

1X800 MW DCRTTP YAMUNA NAGAR SUPERCRITICAL THERMAL POWER PROJECT

TECHNICAL SPECIFICATION FOR CHIMNEY ELECTRICAL WORKS

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**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**

CHAPTER – 25

ILLUMINATION SYSTEM

25.01.00 SCOPE OF WORK

This scope of work shall cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport F.O.R. site of Lighting System, complete with all materials and accessories for efficient and trouble-free operation.

The scope of work shall also include design, engineering installation, testing, commissioning and putting into successful commercial operation of the lighting system supplies.

25.02.00 SCOPE OF SUPPLY

25.02.01 The equipment and materials within the scope of supply shall include but not limited to:

i. Lighting transformer.

Chip efficacy shall be minimum 120 lumen / watt.
Luminaire efficacy shall not be less than 100 lumen / watt
in line with clause 25.09.04 of Chapter 25, Vol-IV.

ii. BEE 5 Star rated LED lights (minimum 120 lumens per watt) .

iii. Lighting panels/boards: Main lighting distribution boards, emergency lighting distribution boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with Energy Saving System.

Energy saving system is not required for lighting panels.

iv. Street lighting poles, flood lighting towers and high masts.

v. Ceiling fans, pedestal fans, receptacles, switches, switchboards, portable emergency lighting unit, portable 24V supply module including handset maintenance equipment etc.

vi. Cables, wires, splicing/termination kits/connection accessories.

vii. Conduit and accessories, junction and pull boxes, terminal blocks.

viii. Grounding materials and connections.

ix. All fittings, supports, brackets, anchors, clamps and connections.

x. Steel for field fabrication of supports and brackets.

25.03.00 SCOPE OF SERVICE

25.03.01 Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the Energy Saving System.

25.03.02 Furnishing of all labour (skilled and unskilled), supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware and transport for timely and efficient execution of the contract work.

25.03.03 Preparation of AS-BUILT drawings showing field modifications, if any.



- 25.03.04 Areas to be covered in BTG package are Turbine generator building (all elevations), Transformer yard, Boiler area including various platforms, coal mill premises including bunker floor & mill maintenance, ESP area including ESP control room, switchgear /MCC rooms, Fuel oil Pressurization pump house, package Boiler building, cable gallery, Service building, DG building, CPU regeneration building, AC equipment & gas room, condensate storage tank & hot well make up and boiler fill pumps area, all roads within battery limit and area illumination of the above premises.
- 25.03.05 Any other area/premises not specifically mentioned here, but which fall under the battery limit of this package are included in the scope.
- 25.04.00 **CODES AND STANDARDS**
- 25.04.01 The design, manufacture and testing of equipment shall be carried out as per the latest Indian/International Standards, Indian Electricity Rules, Relevant Code of Practices and requirements of Govt. of Haryana.
- 25.04.02 All standards and codes of practice mentioned in Chapter 37 shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the stringent shall prevail. All work shall be carried out as per codes and standards mentioned in Chapter 37.
- 25.05.00 **DESIGN CRITERIA**
- 25.05.01 The system provides lighting and electric power supply to all areas of the Power Plant. In addition, it also provides lighting to selected areas during plant emergency conditions.
- 25.05.02 The system shall be installed in an adverse industrial environment. Equipment in some areas shall be subject to vibration, coaldust and oil / water vapours as prevalent in a thermal power generating plant.
- 25.05.03 The design shall be such as to provide minimum lighting levels & lighting fixtures for different areas as per Annexure.
- 25.05.04 The illumination system shall be designed based on best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period.
- 25.05.05 In the hazardous areas like Hydrogen generation plant, fuel oil handling areas or any other gas/ liquid fuel storage/ handling areas in bidder's scope, lighting shall be flame proof.
- 25.05.06 The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group II C as per IS: 2148 or class I, Division II as per NEC 70-428.

- 25.05.07 Bidder shall demonstrate the average lux level achieved for different areas as per specification requirements, after completion of the lighting work, at site to the satisfaction of engineer-in-charge.
- 25.06.00 **SYSTEM CONCEPT**
- The lighting system shall comprise of following sub-systems: -
- 25.06.01 Normal A.C. Lighting
- i) This shall be provided by A.C. lighting fixtures distributed throughout the plant. These lights shall be ON as long as the A.C. supply is available.
 - ii) A.C. lighting fixtures shall be fed from respective area lighting panels, which in turn shall be connected to main lighting distribution board (MLDB). The main lighting distribution boards shall be fed through respective lighting transformer (415V /415V) which forms a part of the MLDB. Normal A.C. supply thus made available for the Normal lighting system is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20% spare outlets.
- 25.06.02 Normal cum Emergency A.C. Lighting
- i) Emergency A.C. lighting shall be provided in Main Plant Building (all elevations), boiler area, boiler galleries, Service Building, DG Building, Transformer yard, ESP Area, ESP control room, CPU Regeneration Area, Fuel Oil Pressurization Pump House, FGD Area and 400 kV Switchyard Control Room for general visibility, safe movements and operation of important auxiliaries.
 - ii) The emergency LDBs (ELDB) are similar to the MLDB except that lighting transformers (415V/415V) in this case are fed from Emergency Services PMCC bus having D.G. System backup. Thus, power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.
 - iii) The lighting fixtures connected to this system shall be available whenever normal supply is available in the plant and also when DG set supplies power to 415V A.C emergency bus.
 - iv) At least 20% of the fixtures shall be fed from AC emergency source.
- 25.06.03 Emergency D.C. Lighting
- i) This will be provided by D.C. lighting fixtures located strategically in critical operating areas and emergency exits. Emergency D.C. lighting fixtures will be fed from respective area DC lighting panels (DCLP) either through cable junction box or direct, which in turn will be connected to DC Emergency Lighting Distribution Board (DCELDB).
 - ii) These lights shall be normally OFF. In case of failure of AC system, these lights shall be energized from the DC supply through automatic switching. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply AC supply. LED suitable for 220 V DC operation may be used for DC emergency lighting.

- iii) Lighted Exit signs shall be provided and installed in the control room, switchgear room, relay room, maintenance areas.
- iv) In auxiliary/off site buildings except CHP emergency DC lighting is to be provided using 'Instalite' type fixtures which is permanently connected to normal supply charging a battery having four (4) hours back up. These shall switch "ON" automatically when AC power supply goes "OFF".
- v) For CHP 18W LED DC lighting fixture shall be provided in underground portion of the conveyor, each switchgear room, control room, office room and pump houses.

25.06.04 Street/Area Lighting

Time switch and photocell shall be used for controlling streetlights with provision for manual override.

Illumination to the roads shall be provided by providing street lighting poles.

25.07.00 RATING & REQUIREMENT

25.07.01 The lighting system shall be supplied from 415 V/415 V $\pm$ 10%, indoor, dry type cast resin encapsulated lighting transformers. Rating of each transformer shall be decided to limit the fault level within 10 kA.

25.07.02 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

25.07.03 Switch, miniature circuit breakers (MCB), MCCB, bus bars shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

25.07.04 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

25.07.05 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

25.07.06 Heavy duty XLPE FRLS cables shall be used only for connections:

- i. From PCC/PMCC/MCC to Main lighting distribution boards.
- ii. From main lighting distribution boards to area lighting panels.
- iii. From street/area lighting panel to street light poles/towers

25.07.07 Lighting of all main streets, approach roads to various buildings etc shall be included.

25.07.08 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.



25.08.00 **METHOD OF CALCULATION**

25.08.01 Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.

25.08.02 The coefficient of utilization shall be considered to take care of Lumen loss due to: -

- i. Effect of room dimensions
- ii. Absorption of light in luminaries
- iii. Absorption of light at various room surfaces in ceiling, wall etc.
- iv. Floor cavity, ceiling cavity
- v. Mounting height

25.08.03 Additionally, a maintenance factor shall also be considered to account for the fall of illumination due to ageing, pollution like dust deposit etc.

Maintenance factors to be considered for various areas shall be as follows: -

Area	Maintenance factor
i) Air-conditioned indoor area	0.8
ii) Non-air-conditioned indoor area	0.7
iii) Dust prone indoor and outdoor areas	0.6

Apart from maintenance factor given above, Temperature Correction Factor shall be considered in the lighting design for fixtures located in non-air-conditioned areas.

25.08.04 **Reflectance Factor**

- i. Dusty area such as conveyor galleries/tunnels, TPs/ Crusher House etc. = 50% ceiling, 30% wall, 10% floor.
- ii. Clear areas such as switchgear room / control room etc. = 70% ceiling, 50% wall, 10% floor.
- iii. Working plain = a) At conveyor walkway level. B) At building floor level.

25.08.05 The Voltage drop from main lighting distribution board to any fixture shall not exceed 3%.

25.08.06 Circuit loading of each lighting panel shall be done in such a way that almost balanced loading in all the phases i.e., R, Y and B is achieved.

25.08.07 At least two sub circuits shall be used for illumination of a particular area.

25.08.08 Sub circuit loading of each lighting panel shall be restricted to 2000W or 10 Nos. fixtures whichever is lower.

25.08.09 The working plane shall be considered at 0.85 m from

25.08.10 The value of the ratio of spacing (S) to mounting height shall be commensurate with the type of fittings selected, uniform suspension height for suspended fixtures shall not exceed 1 meter.

Sub circuit loading of each lighting panel shall be restricted to 2000 W or 18 (approx) number of fixtures, whichever is lower. Since fixtures used are LED wattage of fixtures is low, 10 no of fixtures per sub-circuit shall lead to non optimisation of circuits.

25.09.00 SPECIFIC REQUIREMENTS - SUPPLY**25.09.01 Equipment and Material**

- i. Equipment and material shall comply with description, rating, type and size as detailed in this Specification, drawings, Datasheet and Annexures.
- ii. Equipment and materials furnished shall be complete and operative in all details.
- iii. All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment, or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- iv. All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

25.09.02 Lighting Transformers

- i. Lighting transformers shall be three phase Delta / star, 415V / 415V Natural air-cooled dry type encapsulated epoxy cast resin insulated, indoor type dusty vermin proof having 415 V/415 V $\pm 2 \times 2.5\%$ with off load tap-changer on primary side. The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding. Rating of each lighting transformer shall be selected to cater to the maximum connected lighting. The casing of the transformer shall be grounded at least at two (2) points. Insulation class shall be 'F' with temperature rise limited to Class B.
- ii. KVA rating : 100/50 KVA
- iii. Vector Group : Dyn11
- iv. Maximum Temperature rise over 50° C ambient in winding by resistance : 90 °C
- v. Neutral : Solidly grounded

25.09.03 Fittings and accessories for lighting Transformers

Each transformer shall be equipped with fittings and accessories as listed below: -

- i. 150 mm dia winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.
- ii. Handling and lifting lugs both for enclosure and core-coil assembly.
- iii. Jacking pad for core-coil assembly.
- iv. Inspection covers for cable end box.
- v. Door handle operated safety limit switch with 1NO + 1NC contact.

- vi. Necessary earthing.
- vii. Rating and terminal marking plates.
- viii. Note: All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 240 V A.C.
- ix. If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

25.09.04 Lighting Fixtures

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for hazardous areas conventional type luminaires shall be used. However, aviation light in Lighting Mast shall be of LED type. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.

The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 100 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be "cool day light" (min 5700K) type for indoor areas. However, for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. The LED luminaries shall have a minimum life of 25000 burning hours with 80% of lumen maintenance at the end of the life. LED shall conform to the LM 80 requirements.

The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.

Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and waterproof protection as per IS 12063.

Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop one connection of PVC wires of following sizes: -

- a) Lighting fixture: 2.5 Sq.mm Copper
- b) Flood Light fixture: 2x2.5 Sq.mm Copper

25.09.05 Driver Circuit

LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer.

LED Drivers shall have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Surge Protection

25.09.07 Lighting Panel/Distribution Boards

- Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated, fixed type from CRCA sheet steel minimum 2.5 mm thick for load bearing members and 2.0mm for non-load bearing members, suitable for either wall/column mounting on brackets or floor mounting on channel sills. The panel shall be provided with lifting hooks. The LPs shall be connected to LDB only.
- Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-54 or better. Outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle housing transformer shall be minimum IP-42.
- Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements. The LDB shall be fixed on a bottom channel 75mm.
- Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminum cable lugs are to be furnished.
- The incoming to each Normal and Emergency AC Lighting Panel shall be provided with a triple pole MCB with neutral isolating facility and one earth leakage circuit breaker. Combined type triple pole MCB and earth leakage circuit breaker (ELCB) are also acceptable for incomers to Lighting Panels.
- Normal and Emergency AC lighting panels shall have outgoing MCBs having thermal elements for overload protection and an instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 9 kA (minimum) at 230 V AC.
- Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.
- Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc.
- Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on

inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminum with inscriptions indelibly etched on it.

- x. Bus bar shall be electrolytic grade hard drawn aluminum, colour coded for easy identification and designed for a maximum temperature of 85 deg C. Minimum size shall be 25 x 6 mm. The current density of aluminum bus bar should not be below 0.8 Amp/Sq.mm. The bus bar shall be provided with heat-shrunk/cold-shrunk PVC sleeve.
- xi. Board / Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase bus bars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker is available on the front.
- xii. Incoming and outgoing circuits shall be terminated in suitable terminal blocks.
- xiii. The incomers of Main and Emergency AC Lighting Distribution Boards (MLDB & ELDB) shall be provided with electronic energy (kWh) meters with suitable communication ports for interfacing with EMS to measure the energy consumed by the lighting loads. The energy meters shall be 3 phase, 4-wire type suitable for measurement of unbalanced loads.
- xiv. In lighting and receptacle panel 3-phase and 1-phase MCB should not be mixed.
- xv. In high bays, walkway shall be provided for maintaining light fittings. At other places suitable ladder / platform / approach shall be provided for maintaining / replacement of light fittings.

25.09.08 Board/Panel Equipment

- i. Each board shall consist of two dry type transformers housed in the different cubicles and a bus coupler. one (1) V.T operated voltmeter with selector switch, one (1) C.T operated ammeter selector switch, VTs, CTs, three (3) Nos. phase energized indication lamps backed up by fuses and incoming triple pole MCCBs. Proper discrimination between outgoing MCCB of lighting distribution board and downstream MCCB of lighting panel shall be ensured.
- ii. Each lighting panel shall have an incoming triple pole MCCB with neutral link along with a suitably rated ELCB and a number of outgoing miniature circuit breakers (MCB).
- iii. Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.
- iv. All MCCB shall be single throw, air break and heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type.
- v. Contactors shall be air-break electromagnetic type. Push buttons shall be push to actuate type.

- vi. MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.
- vii. Time switch in street lighting panels shall be photocell type with automatic voltage stabilizer and necessary electronic unit with provision for sensitivity adjustment depending on external light intensity. When the exterior illumination level shall fall below a preset value for a considerable period of time (adjustable 30 sec. to 180 secs.) the electronic unit shall generate signal for the output relay to pick-up and potential-free contact of the same shall be used for control of contactor for lighting system. Sustained normal illumination level being restored (adjustable 30 sec. to 180 sec.) the lights shall switch off.
- viii. Voltmeter / Ammeter shall be of accuracy class 2.0 or better as per IS: 1248 Voltmeter / Ammeter selector switch shall be of reputed make.

25.09.09 Receptacles

- i. Receptacles shall be heavy duty, complete with individual plug and switch.
- ii. The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of 3rd pin.
- iii. Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.
- iv. Chimney
 - 1. 3 Pin Receptacles designed for IP:55 degree of protection shall be provided at every platform level, rated for 20A, 240 V, AC. The Receptacles shall be complete with 20A, 240V, AC switch and 3 pin plug.
 - 2. Heavy duty welding Receptacle rated for 415V, AC, 63A shall be provided at each internal platform level.

25.09.10 Fans & Regulators

- i. The fan shall have three well balanced blades. Double ball bearings and shall be reasonably free from noise. Sweep shall be 1200 / 1400 mm Pedestal fans shall also be provided as per Owner's requirement.
- ii. Fan motor shall be totally enclosed type with copper winding & class E insulation.
- iii. Regulator shall have minimum five steps. Electronic regulator with smooth control is preferred.

25.09.11 Switch & Switch Board

- i. All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick Bakelite cover with brass fixing screws.



- ii. Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.
- iii. Switch boards / boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.
- iv. Flush type receptacles where provided shall be so located that only the plug projects outside.
- v. Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.

25.09.12 Lighting Poles & Flood Light Tower

DELETED



"1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR"



25.09.14 Special Requirement

- i. All outdoor illumination fixtures, unless it is fed from photocell/time switch-controlled lighting panel, has to be provided with outdoor type local switches.
- ii. In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied the wiring and fixing of the same has to be done by the Bidder.

25.09.15 Conduits and Accessories

- i. Conduits shall be rigid steel, hot dip galvanised, furnished in standard length of 3M, threaded at both ends.
- ii. Conduits up to and including 25 mm shall be of 14 SWG and conduits above 25 mm shall be of 16 SWG. Minimum size of conduits shall be 20 mm.
- iii. Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

- iv. Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

25.09.16 Junction Box

JB shall be IP-55

- i. Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-66.
- ii. Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.
- iii. Junction boxes for outdoor use shall weatherproof IPW-66 and those for hazardous location shall be flame-proof type.
- iv. Junction boxes shall have following indelible markings:
- Circuit Nos. on top
 - Circuit Nos. with ferrules (inside) as per drawing
 - DANGER sign in case of 415V circuit

25.09.17 Lighting Cables & Wires

- i. Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminum conductor, XLPE insulated, extruded FRLS PVC type ST2 inner sheath, single round G.I. wire armoured and overall FRLS PVC type ST2 sheathed conforming to IS 1554.
- ii. Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below:-

RED for R-Phase	BLACK for Neutral
YELLOW for Y-Phase	WHITE for + 'Ve D.C.
BLUE for B-Phase	GREY for - 'Ve D.C.

- iii. Wire size shall be as follows:

From LP to JB main run 2.5 sq.mm Copper wire shall be provided.

For point wiring beyond lighting panel i.e., from lighting Panel to junction box (main run)	:	10 sqmm aluminum. Stranded conductor
From Junction box to lighting fixture	:	2.5 sqmm Copper. Stranded conductor.
Receptacle	:	4 sqmm Copper

25.09.18 Terminals

- i. Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.
- ii. Each terminal shall be suitable for connection up to 2 Nos. 10 Sq.mm stranded aluminum conductors without any damage to the conductor or looseness of connectors.



25.09.19 Portable Emergency Lighting Unit

The portable emergency lighting unit shall be complete with 6 V storage battery (rechargeable), inverter, automatic charger, twin 6W fluorescent tube lamp and test switch. Bidder shall furnish make, type and catalogue. Minimum of 20 Nos. to be supplied.

25.09.20 24V Supply Module

- i. Each 24V A.C. supply module shall have one (1) No. air-cooled two winding, 500VA, 1-phase, 50HZ, 240/24V transformer with 6A (240V side) and 16A (24V side) HRC fuse in primary and secondary side and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 16A, 24V AC receptacles located near condenser area shall be wired up to from 24V side of each 24V A.C supply module.
- ii. The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.
- iii. Minimum 15 Nos. portable 24 V AC Supply modules having sheet steel enclosure with louvers as per above shall be supplied for each unit 24V halogen automobile lamp with reflector along with 1100 V twin core PVC sheathed 2.5 sqmm stranded copper wire of 20 M length as handset.

25.09.21 Nameplate

- i) Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions.
- ii) All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

25.09.22 Samples

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

25.09.23 Occupancy based Passive Infra-red sensors

The sensors shall be recess mounted, programmable type suitable for lighting load. The detection area shall be minimum 5 metres for standard room height of 3mt. All the calibrated settings shall be stored in non-volatile memory of PIR sensor which shall be unaffected by power supply fluctuations. Necessary 16A contactor shall be supplied along with each sensor & shall be located inside the switch box. Movement based sensors shall be used in common rooms, Staircases, Store Room & Washrooms. Presence based sensors shall be used for Office Cabins, Conference Halls & Meeting Rooms.

25.09.24 Aviation Obstruction Lighting System for Chimney and NDCT

Aviation obstruction lighting system shall conform to the requirements of the latest applicable rules of International civil aviation organization (ICAO) and NAA/DARA regulations.



The aviation obstruction lighting system shall be of high intensity type.

Photo electric controller shall be housed in rugged weather tight, IP 65 enclosure. LED's shall be provided to indicate the operation status of the unit.

System controller shall be suitable for operation at specified ambient temperature and shall be wall mounted type. The enclosure shall have IP:55 degree of protection.

Aviation obstruction light unit shall provide easy access to lamp and components.

Four Nos. of obstruction lights shall be installed on outdoor platforms of chimney and at suitable locations on NDCT. The system controller is proposed to be located at 1.2 metre elevation and photo electric controller at about 40 metre elevation. Necessary cables for wiring between photocell & system controller and between system controller & obstacle lights shall be provided

Each item shall be preassembled, routine tested optically and electrically before despatch.

The distance between lighting elevations shall not be more than 105 Metre and lowest lighting elevation shall not be less than 70 metre.

The light unit shall have adjustable bracket with level indicator to ensure accurate vertical placement of the light flash.

High intensity obstacle lights shall meet the following requirements: -

- (a) It shall be flashing white light. The effective intensity of obstacle light shall be variable and dependent on background luminance as follows.

S. No.	Background Luminance	Effective Intensity
1.	Above 500 cd/sq m	200000 cd $\pm$ 25% cd
2.	50 to 500 cd/ sq m	20000 cd $\pm$ 25% cd
3.	Less than 50 cd/ sq m	4000 cd $\pm$ 25% cd

- (b) The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute.
- (c) The system shall also provide automatic sensing and display of system status and aviation lamp failure detection

Aviation obstruction lighting shall be powered from AC emergency power supply.

Temporary obstruction lighting shall be provided during construction. Obstruction lights shall be provided on the uppermost part of the chimney, or the surrounding scaffolding. As construction progresses each completed level shall be provided with temporary lighting. Temporary obstruction lights shall have four fixtures located in a horizontal plane on the chimney/NDCT structure to ensure unobstructed visibility of at least one obstruction light from aircraft at any normal angle of approach. Power for operation of the temporary obstruction lights shall be obtained from the construction power system.

Supply circuit for these lights shall be furnished, installed and maintained by the Bidder. Temporary obstruction lights shall be operated from sunset to sunrise during each day of the contract period until permanent Aviation Obstruction Warning Lighting (AOWL) are installed.

25.10.00 **SPECIFIC REQUIREMENTS-SERVICES**

25.10.01 Consumables and Hardware

- i. The Bidder shall furnish all erection materials, hardware and consumables required for the completed installation.
- ii. The materials shall include but not limited to the following: -
 - a. Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
 - b. Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
 - c. Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.
- iii. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

25.11.00 **ERECTION TOOLS & TACKLES**

25.11.01 The Bidder shall provide all tools, tackle, implements, scaffoldings, ladders, etc. which are required for handling and erection of the equipment and materials.

25.11.02 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

25.11.03 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

25.11.04 Street Lighting Poles

Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of Bidder.

25.11.05 Flood Lighting Tower

- i. Erection of Flood Lighting Towers including civil foundation work shall be done by Bidder.
- ii. Bidder shall also mount assembled fixtures; outdoor & lockable type isolating switch cubicle install necessary cabling and wiring make connections.



- iii. Floodlights shall be mounted on steel base facing the tentative direction shown on the drawing. Fixing holes shall be provided with slot to turn the fixture about 5° on both sides. Bolts shall be finally tightened with spring washer.
- iv. The Bidder shall supply and install the steel base for fixing the flood light on the flood light towers.
- v. Terminal connections to the floodlight shall be made through PVC coated flexible metallic conduits.

25.11.06 Receptacles

Receptacles shall be installed at locations shown in the approved drawings.

25.11.07 MLDB, EMLDB, DCLDB and Lighting Panel

MLDB, EMLDB, DCLDB and Lighting Panels shall be erected at the locations indicated in approved drawings.

25.11.08 Lighting High Masts

Erection of Lighting Masts together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of Bidder.

25.11.09 Lighting Fixtures

- i. Continuous rows of LED based tube lights shall be mounted on a continuous M.S. angle for each row of lights.
- ii. In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.
- iii. Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity.
- iv. If a roof over platform is available, the fixture can be pendant mounted.
- v. The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

25.11.10 Wiring

- i. Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.
- ii. Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.



- iii. Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.
- iv. For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.
- v. For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.
- vi. A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.
- vii. Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.
- viii. Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

25.12.00 CONDUIT SYSTEM

- 25.12.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.
- 25.12.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.
- 25.12.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.
- 25.12.04 Conduits shall be clamped on to approved type space plates or brackets by saddle or U-bolt. The spacer plates or brackets in turn, shall be fixed to the building by welding and to concrete or brick work by grouting as shown on drawing.
- 25.12.05 Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.
- 25.12.06 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.
- 25.12.07 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.
- 25.12.08 Where conduits are run on cable trays, they shall be clamped to supporting steel at an interval of 600 mm.
- 25.12.09 For directly embedding in soil, the conduits shall be coated with an asphalt base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.



- 25.12.10 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.
- 25.12.11 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.
- 25.12.12 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.
- 25.12.13 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change shall cause no distortion due to expansion or contraction of conduit run.
- 25.12.14 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.
- 25.12.15 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.
- 25.12.16 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.
- 25.12.17 Conduit joints and connections shall be made thoroughly watertight and rust proof by application of a thread compound which shall not insulate the joints.
- 25.12.18 White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 25.12.19 The battery Room installation shall be made with acid fume proof conduits.
- 25.12.20 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.
- 25.12.21 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.
- 25.12.22 Lighting fixture shall not be suspended directly from junction box in the main conduit run.
- 25.12.23 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.
- 25.12.24 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- 25.12.25 In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.
- 25.12.26 Cabling
- i. In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the above ground portion.



- ii. Buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast concrete slab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.
- iii. When buried cables crossroad/railway track, additional protection to be provided in form of G.I. pipe.

25.12.27 Grounding

- i. All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.
- ii. Ground connections shall be made from nearest available ground grid. All connections to ground grid shall be done by arc welding.
- iii. Panels/Boards shall be directly connected to ground grid by two Nos. 35 x 6 mm G.S. flats. (For panels/two Nos. 50x6 mm G.S. flats (for distribution boards).
- iv. All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 8 SWG G.S. wire.
- v. Each street lighting Pole shall be grounded at two points by two Nos. 50x6 mm G.S flat risers from two (2) Nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) Nos. earthing terminals by 16 SWG GS wire. One 16 SWG G.S wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.
- vi. Two (2) Nos. earthing spike 3m long & 40 mm dia directly driven into ground at a depth of 1m from ground level shall be provided for each flood lighting tower.
- vii. The sheet steel cubicle housing the power supply Isolator at base of flood lighting tower shall be connected at two (2) points from these earthing risers by 16 SWG G.S. wire - The flood lighting fixtures shall be grounded by one (1) 16 SWG G.S wire running through the lighting conduct up to the distribution box.
- viii. Two (2) Nos. separate spike of 3m long & 40 mm dia directly driven into ground at a depth of one (1)m from ground level shall be provided for connection of the lighting must on top of flood lighting tower through two (2) Nos. 50x6 mm G.S. flat down conductor.
- ix. A continuous ground conductor of 12 SWG G.S. wire shall be run all along each conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.

Lighting Fixture DOP:
Recess Mounting: IP 20;
Indoor: IP 55 &
Outdoor: IP 65

Grounding shall be done using 14 SWG
GI wire.

25.12.28 Foundation & Civil Works

- i. Equipment foundations panel foundations and all other civil work shall be provided by the Bidder.



- ii. Concrete trenches, cable trays and other civil work shall be provided by the Bidder. The Bidder can make use of those trenches, cable trays etc. for conduit installation.

25.12.29 Excavation and Back Filling

- i. The Bidder shall perform all excavation and backfilling as required for buried cable and ground connections.
- ii. Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.
- iii. The Bidder shall make use his own arrangements for pumping out any water that may be accumulated in the excavation.
- iv. All excavation shall be backfilled to the original level with good consolidation.

25.12.30 Steel Fabrication

- i. All supports, hangers & brackets shall be fabricated by the Bidder. Necessary steel shall be supplied by the Bidder.
- ii. Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

25.12.31 Painting

- i. All steel fabrication shall be given two coats of primer followed by two coats of Siemens gray (RAL-7032) Epoxy Paint.
- ii. All equipment shall be given touch-up paint as required after installation.

25.12.32 Cleaning up of Work Site

- i. The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or driveways.
- ii. Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

25.12.33 Inspection & Testing

- i. On completion of erection works, the Bidder shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.
- ii. The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Bidder.
- iii. The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.



- iv. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Bidder without any extra cost.

25.13.00 TESTS

All tests specified under this clause shall be carried out as per applicable standards.

25.13.01 Type Tests

Type test reports for LED as per standards shall be submitted for approval.

1. Visual and Dimension check
2. Proof of procurement of LEDs
3. Safety tests
 - a. Marking
 - b. Construction
 - c. Provision for Earthing
 - d. External and Internal wiring
 - e. Protection against electrical shock
 - f. Endurance and Thermal
 - g. Insulation resistance & electrical strength
 - h. Resistance to heat fire & tracking
 - i. Resistance to Humidity
4. Fire Retardant test
5. Performance tests (electrical, Photometric color and Life)
6. Burn-in Test
7. Power Cycling
8. Temperature rise test
9. Emission Tests
 - a. Radiated & conducted emission
 - b. Harmonics & flickers
10. Immunity tests

In addition, following test reports to be submitted for LED chip/LED luminaire:

- a. LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.
- b. LM 80/IS: 16105 report.
- c. LM 79/ IS: 16105 report.

25.13.02 Shop Tests

- i. All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works and in the presence of Owner's representatives.
- ii. Tests on Lighting Distribution Boards/ Lighting Panels shall include:
 - a) Wiring continuity tests.
 - b) High voltage and insulation tests.
 - c) Operational tests.
- iii. The tests on LED lights shall include:
 - a) Colour rendering index (CRI)
 - b) Colour temperature
 - c) Light intensity
 - d) Power consumption
 - e) Dielectric voltage withstand tests
 - f) Assembly check
 - g) THD Test/Harmonics test is done by IS 14700
 - h) Min Max operating voltage test
 - i) Lumen test
 - j) IP Rating Test

25.13.02 Site Tests

- i. Bidder shall thoroughly test and insulation resistance test all cables, wires and equipment to prove the same are free from ground and short circuit.
- ii. If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.
- iii. All equipment shall be demonstrated to operate in accordance with the requirements of this specification.
- iv. Illumination in different areas is as per designed lux level generally confirming with Indian Standards. The lux level shall be verified by photometer at site location.

25.13.03 Test Certificates:

- i. Certified copies of all tests carried out at works and at site shall be furnished in requisite No. of copies for approval of the Owner.
- ii. The equipment shall be dispatched from works only after receipt of Owner's written approval of shop test reports.
- iii. Type test certificates on any equipment, if so desired by the Owner, shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

25.14.00 **DRAWINGS & DOCUMENTS**

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Design basis report
- Illumination design calculation
- ~~Tubular day light guidance system~~
- GA drawing and single line diagram of lighting distribution board
- GA drawing and single line diagram of lighting panel & receptacle panels
- ~~GA drawing of poles and masts~~
- GA drawing of receptacles
- General arrangement drawings of lighting fixtures
- Lighting design software
- Technical data sheet
- Test reports
- Catalogues

DELETED

- Illumination layout for other non-plant buildings
- Illumination and Small power distribution arrangement
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

ANNEXURE-I

LIGHTING & LIGHTING TRANSFORMER

S. No.	ITEM	Unit	
1.0	AUXILIARY POWER SUPPLY		
1.1	SYSTEM VOLTAGE		
	Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources.		
1.1.1	A.C Supply		415 Volt, 3 phase, 50hz, 3 wire effectively grounded system Fault level 50kA rms symmetrical
1.1.2	DC Supply		Fault level 25kA symmetrical 220V, 2wire, ungrounded system.
1.2	PERMISSIBLE VARIATION		
	Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:		
1.2.1	A.C Supply		Voltage $\pm 10\%$ Frequency $\pm 5\%$ Combined voltage and frequency 10% (absolute sum)
1.2.2	D.C Supply		Voltage 187 to 242 Volt
3.0	LIGHITNG TRANSFORMER		
3.1	Type		Cast Resin Dry type, encapsulated
3.2	KVA rating		100/50kVA
3.3	Voltage rating		415 V/415 V
3.4	Cooling		AN
3.5	P.U. Impedance		As required
3.6	Voltage control		Off load tap switch/link with change of $\pm 5\%$ in step of 2.5% tapping full capacity
3.7	Class of Insulation		F (155 Deg. C)
3.8	Maximum Temperature rise over 50 Deg C. ambient in winding by resistance		90 Deg. C
3.9	Neutral		Solidly grounded

Notes:

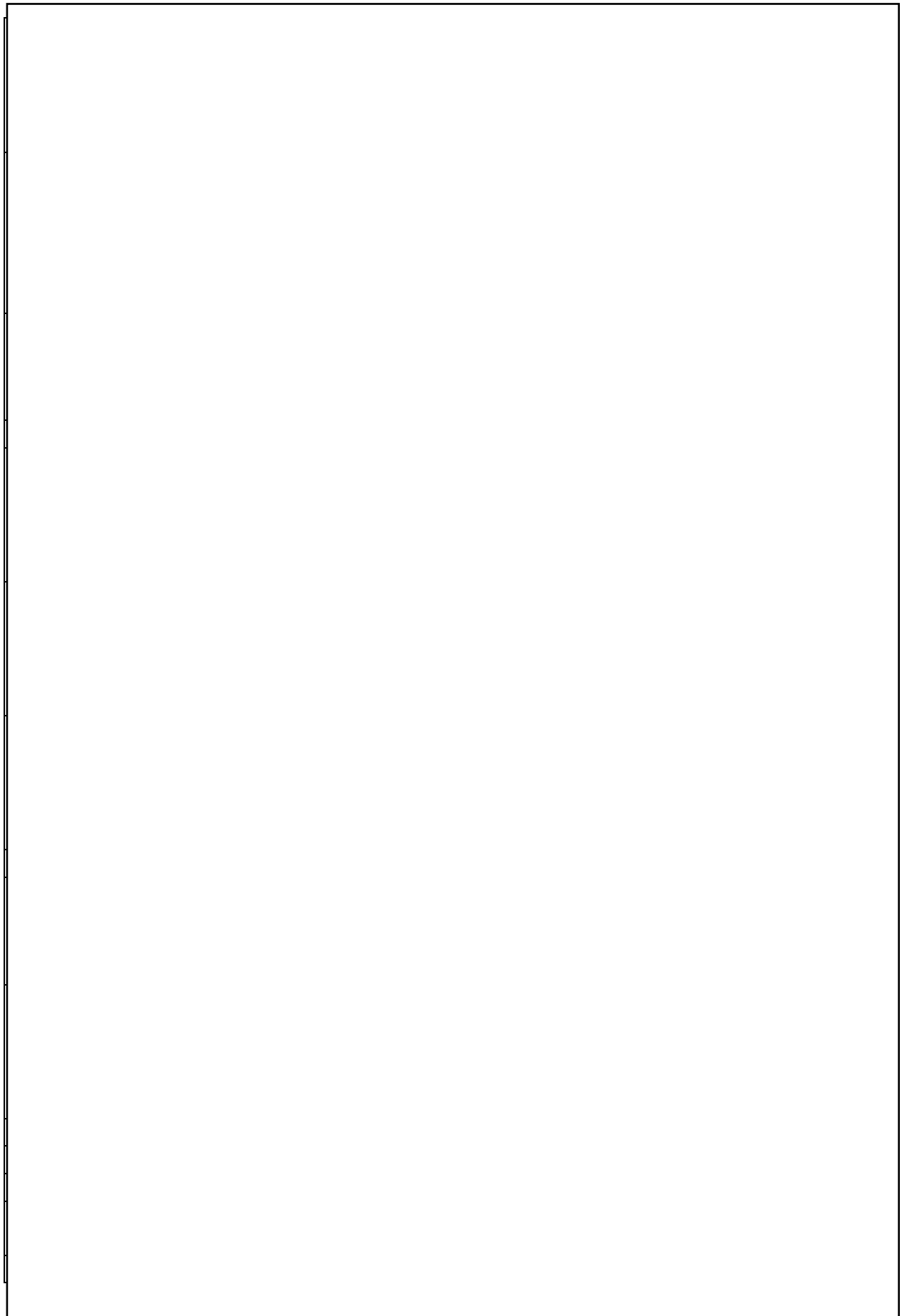
The secondary neutral of the transformer shall be brought out for getting a grounded four (4) wire supply. Each transformer shall be routine tested and one transformer shall be type tested in accordance with relevant standard.

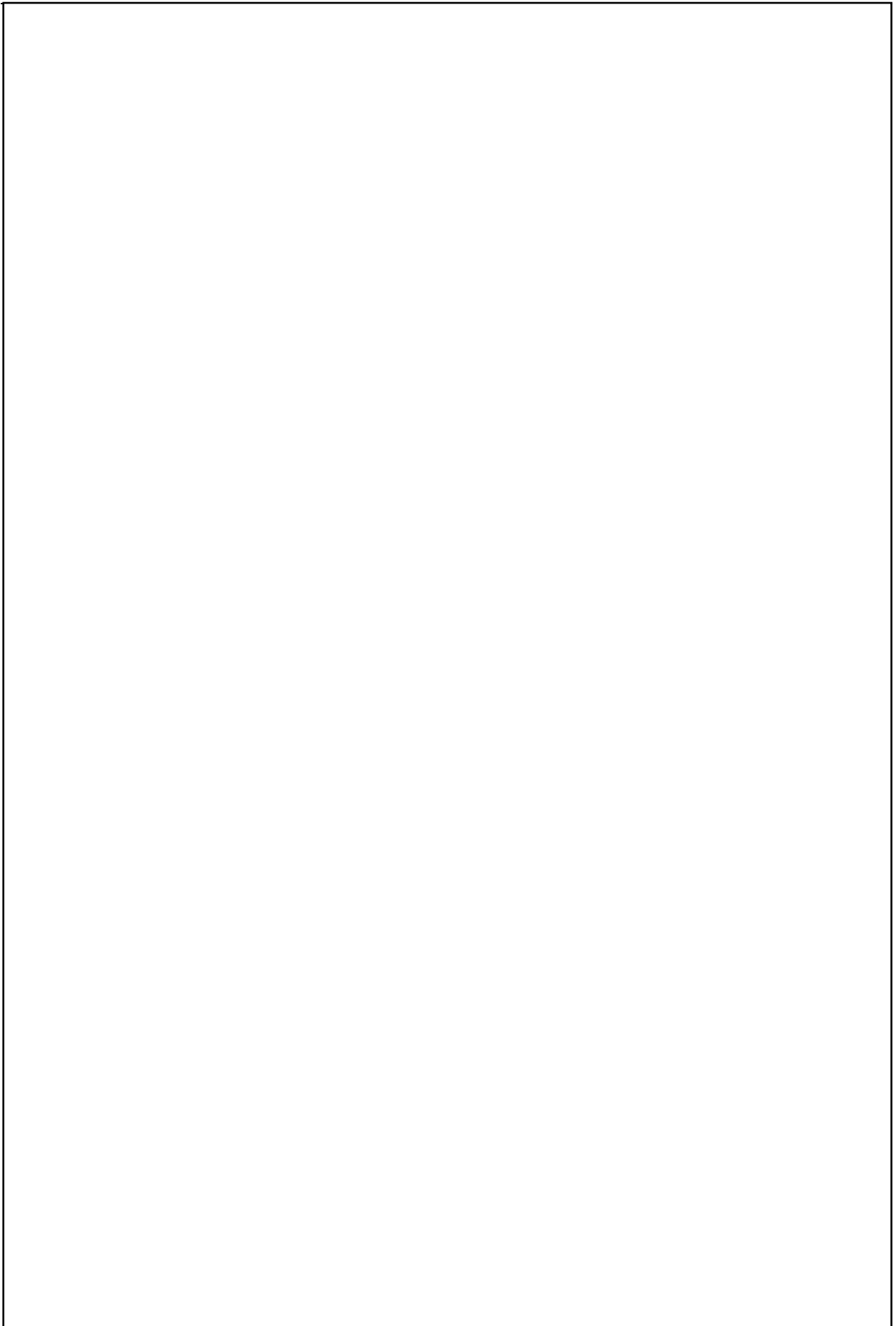
ANNEXURE -II

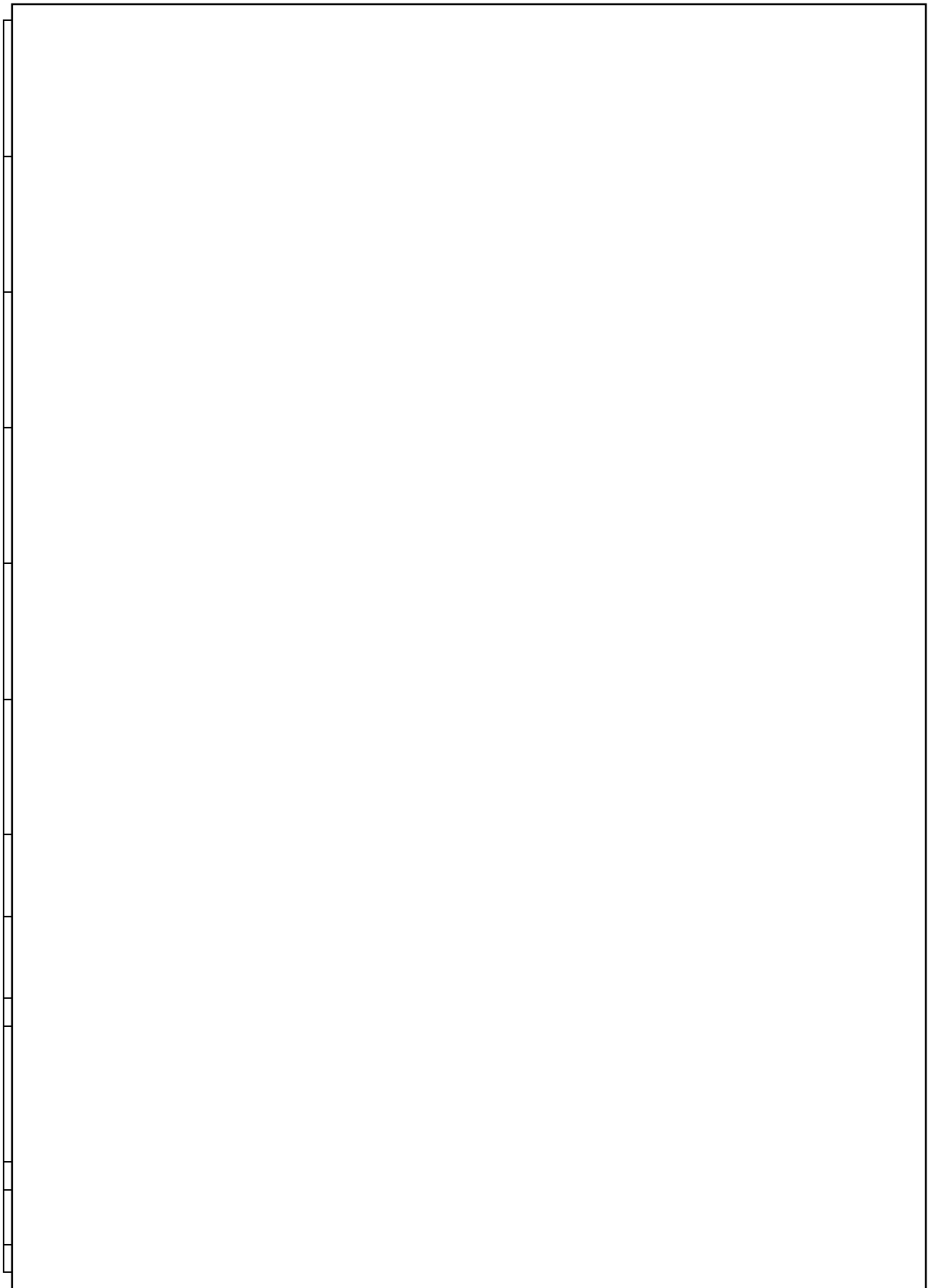
ILLUMINATION LEVELS

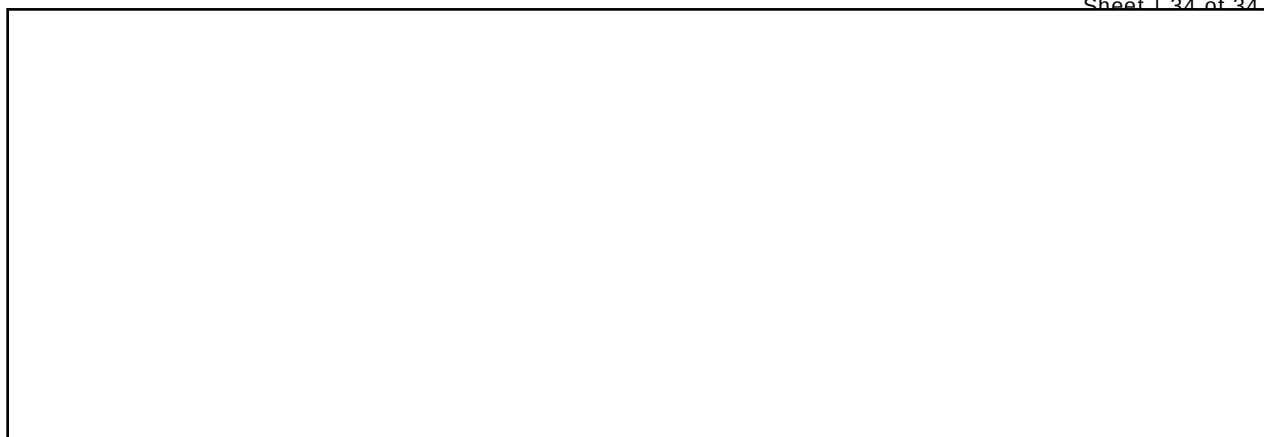
S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port- able
A	TC BUILDING							

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
22.	Staircase	\$C	\$A	Well Glass LED Luminaire for AC LED Industrial Bulkhead for DC	-	-	Y	N
23.	Passage	70	-	LED Luminaire	80%	20%	N	N









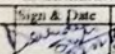
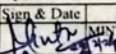
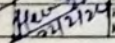
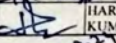
Z	Chimney							
1.	On equipment	150	-	LED Luminaire	80%	20%	N	N
2.	General platform area	70	-	LED Luminaire	80%	20%	N	N
3.	Staircase and landings	100	-	LED Luminaire	50%	20%	N	N

Note:

1. \$A denotes 1 Fixture at every 20 M spacing along walkway.
2. \$B denotes 1 Fixture at Exit/Entry.
3. \$C denotes 1 AC Normal Fixture and 1 AC Emergency Fixture to be provided at every alternate landing.
4. Fire Exit Sign 1 No. to be provided at all exits.
5. In transformer yard & AIS Switchyard lux level shall be 50 (on equipment) and 20 (general).
6. \$D denotes DC fixtures to be provided as per CI 25.06.03 (v).
7. \$E denotes DC portable emergency lighting unit to be provided in JT / TT, Crusher House etc except overground portion of conveyors.
8. Aviation obstruction lighting system shall be provided both for chimney and NDCT.
9. Minimum one (1) light fixture shall be provided at landing in chimney.

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-558-F002, R-J	DATE:
		PROJECT:		PO NO.:	DATE:
		ITEM DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 1 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	10			
					M	B/ C				D	M	B	C
1.0	Raw Material	(a)Material (b)Thickness (c) Surface Finish (d) Chemical Composition	MA	V/M	100%	100%	Manuf. Std. / Approved Document	Manuf. Std. / Approved Document	Test Certificate	√	P	V	-
		Verification of make, type, Size & rating of component like indicating lamps, PB's, contactors, relays, switches etc.	MA	Visual	100%	100%	Approved drg. & Datasheet	Approved drg. & Datasheet	Test Certificate	√	P	V	-
LIGHTING DISTRIBUTION BOARDS & LIGHTING PANELS													
2.0	Final Inspection	1 Dimensions	MA	Measurement	100%	10%	Approved drg. / Datasheet	Approved drg. / Datasheet	Insp. Report	√	P	W	-
		2. Paint shade/ Paint Finish & thickness	MA	Visual/ measurement	100%	10%	Approved drg. / Datasheet	Approved drg. / Datasheet	Insp. Report	√	P	W	-
		3. Verification of GA	CR	Visual	100%	100%	Approved drg.	Approved drg.	Insp. report	√	P	W	-
		4. Verification of BOM	CR	Visual	100%	100%	Approved drg.	Approved drg.	Insp. report	√	P	W	-
		5. Functional tests (incl. wiring cont.)	MA	Elect	100%	100%	Approved drg.	Approved drg.	Insp. report	√	P	W	-
		6. HV/ IR/ HV	MA	Elect	100%	100%	App DataSheet	App DataSheet	Insp. report	√	P	W	-

BHEL				BIDDER/ SUPPLIER		FOR CUSTOMER APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Doc No.			
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name	Reviewed by:	Sign & Date	Name	Seal
Prepared by:		DEVENDRA SINGH	Checked by:		MAYTOO	Reviewed by:			
Reviewed by:		HEMA KUSHWAHA	Reviewed by:		HARISH KUMAR	Approved by:			

222-11

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
		PROJECT:		PO NO.:	DATE:
		ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 2 OF 4

BHEL				QUALITY	
ENGINEERING				Name	
Prepared by:	Sign & Date	Checked by:	Sign & Date	Name	
	DEVENDRA SINGH			MINTOO	
Reviewed by:	Sign & Date	Reviewed by:	Sign & Date	Name	
	HEMA KUSHWAHA			HARISH KUMAR	

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No			
Reviewed by:	Sign & Date	Name	Seal
Approved by:			

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
		PROJECT:		PO NO.:	DATE:
		ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 3 OF 4

I.L.NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENC E DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	
		e). Load Loss/ Current	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		f.) No Load Loss & No Load Current	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		g.) Source Withstand	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		h) Induced O/ V	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		2. Type Test	MA	Verification	-----	1/Ratin g	IS 11171	IS 11171	Test Certificates	√	P	V	-	Type Test Certificate Clearance from BHEL/Customer
4.0	PACKING	As per BHEL Appd. Drg./Packing Procedure	MA	Visual	100%	100%	Appd. Packing Drg./ Packing procedure	Appd. Packing Drg./ Packing procedure	Insp. report	√	P	W	-	

NOTES: -

- (A) THE INSPECTION SHALL BE CARRIED OUT ONCE FOR THE MATERIAL OFFERED FOR INSPECTION IN ONE LOT. FOR SUBSEQUENT LOTS AGAINST THE SAME PROJECT, THE MATERIAL CAN BE ACCEPTED BASED ON CERTIFICATE OF COMPLIANCE FURNISHED BY THE VENDOR.
- (B) BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST, IF REQUIRED.
- (C) AFTER PACKING AND PRIOR TO ISSUE OF MDCC, PHOTOGRAPHS OF COMPLETE MATERIAL (TO BE DISPATCHED) SHALL BE SENT TO BHEL-PURCHASE GROUP FOR REVIEW.
- (D) IN CASE THERE ARE ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE, THE SAME SHALL BE CARRIED OUT BY THE BIDDER

BHEL				BIDDER/SUPPLIER		FOR CUSTOMER APPROVAL			
ENGINEERING		QUALITY		Sign & Date		Doc No			
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name	Reviewed by:	Sign & Date	Name	Seal
Reviewed by:			Reviewed by:			Approved by:			

	MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
		PROJECT:		PO NO.:	DATE:
		ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 4 OF 4

	WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
(E)	PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
(F)	FOR EXPORT JOB, PACKING SHALL BE AS PER BHEL SEAWORTHY PACKING SPECIFICATION

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,

P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE

MA: MAJOR, MI: MINOR, CR: CRITICAL

BHEL			
ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
Prepared by: <i>[Signature]</i>	DEVENDRA SINGH	Checked by: <i>[Signature]</i>	MINTOO
Reviewed by: <i>[Signature]</i>	HEMA KUSHWAHA	Reviewed by: <i>[Signature]</i>	HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No.			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

22.2.24

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO :		DATE:	
			CUSTOMER :					QP NO.:PE-QP-999-558-E001, R05		DATE: 22.02.2024	
			PROJECT:					PO NO.:		DATE:	
			ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS			SYSTEM:STATION LIGHTING SYSTEM		SECTION: II		SHEET 1 OF 6	
SL NO.	COMPONENT & OPERATIONS	CHARACTERIST ICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTAN CE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	* D	** M B C	
					M B/ C						

1.0 LED TYPE LIGHTING FIXTURES

LED TYPE LIGHTING FIXTURES														
A	Bought out items / in-process checks													
1.1	LED chip	LED chip efficacy	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	✓	P/V	V	V	At the time of final inspection
		LED chip CRI & CCT	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	✓	P/V	V	V	At the time of final inspection
		Reported TM21 (L80) lifetime of LED chip	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	✓	P/V	V	V	At the time of final inspection
1.2	LED Driver	Compatibility with LED module / chip, controls & protection features	Major	Visual	Manufacturer Standard	-	Approved GA drawing	Approved GA drawing	Certificate of Compliance	✓	P/V	V	V	Certificate of Compliance by LED driver manufacturer / lighting fixture supplier that driver meets all requirements as per approved GA Drawing
		THD & pf check	Major	Electrical	Manufacturer Standard	-	Approved GA drawing	THD <10% and pf ≥0.9	Inspection report	✓	P/V	-	-	Refer note No. 1

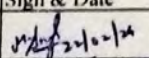
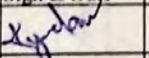
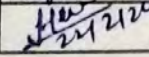
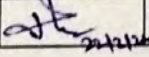
BHEL				
ENGINEERING		QUALITY		
	Sign & Date	Name	Sign & Date	Name
Prepared by:	<i>[Signature]</i>	MEET SAGAR SINGH RAJPAL	Checked by:	<i>[Signature]</i> Kundan
Reviewed by:	<i>[Signature]</i>	HEMA KUSHWAHA	Reviewed by:	<i>[Signature]</i> Harish

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO :		DATE:	
			CUSTOMER :					QP NO.:PE-QP-999-558-E001, R05		DATE: 22.02.2024	
			PROJECT:					PO NO.:		DATE:	
			ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS			SYSTEM:STATION LIGHTING SYSTEM		SECTION: II		SHEET 2 OF 6	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	* D	**			
					M	B/ C					M	B	C	
1.3	Castings	Freedom from defects	Major	Visual	Manufacturer Standard	-	Manufacturer Standard	Casting shall be free from any defects such as blow holes , surface blisters , cracks and cravities etc.	Inspection report		P/ V *	-	-	Refer note No. 1
1.4	Sheet metal forming and fabrication	Freedom from defects	Major	Visual	Manufacturer Standard	-	Manufacturer Standard	Manufacturer Standard	Inspection report		P/ V *	-	-	Refer note No. 1
1.5	Pre-treatment and powder coating	Pre-treatment process checks, Powder Coating finish, thickness , uniformity of coating and adhesion	Major	Visual, chemical & mech	Manufacturer Standard	-	Manufacturer Standard	Nominal coating thickness 50 microns or more	Inspection report	√	P/ V *	V		Refer note No. 1

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		MEET SAGAR SINGH RAJPAL	Checked by:		Kundan
Reviewed by:		HEMA KUSHWAHA	Reviewed by:		Harish Kumar

BIDDER/ SUPPLIER	
Sign & Date	
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	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO :		DATE:		
			CUSTOMER :					QP NO.:PE-QP-999-558-E001, R05		DATE: 22.02.2024		
			PROJECT:					PO NO.:		DATE:		
			ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS			SYSTEM:STATION LIGHTING SYSTEM		SECTION: II		SHEET 3 OF 6		
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY	REMARKS
1	2	3	4	5	6		7	8	9	*	**	
					M	B/ C				D	M B C	

B	Acceptance Tests on LED Lighting fixtures													
1	LED Lighting fixture	LED chip make	Major	Visual	-		Accepted type test reports (LM80) report	LM80 report	Certificate of compliance	√	V	V	V	
2		Constructional features including: Internal wiring , terminal block, earthing terminal, safety chain (if applicable)	Major	Visual	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
3		Degree of protection test in case of lighting fixtures having IP X4 and above rating.	Major	Mechanical	1 Sample per type	1 Sample per type	IS 10322	Approved GA drawing	Certificate of compliance	√	P	W	V	
4		Resistance to dust (applicable if IP5X and above)	Major	Optical	Manufacturer Standard	-	IS 10322	Approved GA drawing	Certificate of compliance	√	P/V *	V	V	Refer note No. 1
5		Photometry check	Major	Optical	Manufacturer	-	LM79, IS 16106	Approved GA drawing	Certificate of	√	P/V	V	V	Refer note No. 1

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	<i>[Signature]</i>	MEET SAGAR SINGH RAJPAL	Checked by:	<i>[Signature]</i>	<i>Kundan</i>				Reviewed by:		
Reviewed by:	<i>[Signature]</i>	HEMA KUSHWAHA	Reviewed by:	<i>[Signature]</i>	<i>Hansa</i>				Approved by:		

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO :		DATE:	
			CUSTOMER :					QP NO.:PE-QP-999-558-E001, R05		DATE: 22.02.2024	
			PROJECT:					PO NO.:		DATE:	
			ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS			SYSTEM:STATION LIGHTING SYSTEM		SECTION: II		SHEET 4 OF 6	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	

					Standard				compliance		*			
6		Dimensions	Major	Visual	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
7		LED driver: THD and pf check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	THD<10% and pf >= 0.9	Inspection report	√	P	W	W	At lighting fixtures supplier test lab.
8		LED driver: Precision current control check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
9		LED driver: Open circuit protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
10		LED driver: short circuit protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
11		LED driver: overload protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
12		LED driver: surge protection	Major	Electrical	1 Sample	1 Sample	Approved GA drawing	Certificate of compliance	Certificate of	√	V	V	V	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	<i>[Signature]</i>	MEET SAGAR SINGH RAJPAL	Checked by:	<i>[Signature]</i>	<i>[Signature]</i>
Reviewed by:	<i>[Signature]</i>	HEMA KUSHWAHA	Reviewed by:	<i>[Signature]</i>	<i>[Signature]</i>

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN				SPEC. NO :		DATE:	
		CUSTOMER :				QP NO.:PE-QP-999-558-E001, R05		DATE: 22.02.2024	
		PROJECT:				PO NO.:		DATE:	
		ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS		SYSTEM:STATION LIGHTING SYSTEM		SECTION: II		SHEET 5 OF 6	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	* D	** M B C
		compliance check			e per type	e per type	that surge protection is provided.	compliance		

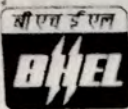
3.0 JUNCTION BOXES & RECEPTACLES

A	Acceptance Tests													
1	Acceptance Tests	Dimensions	Major	MEASURE MENT	100%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	Components shall be of approved Make
2		Paint Shade/ Thickness	Major	VISUAL/ME AS.	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	At the time of final Inspection
3		HV/ IR	Major	ELECT.TES TS	100%	-	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	Inspection report		P	V	-	
4		Degree Of Protection	Major	TEST	1 Sampl e/Type	-	IS:2147	IS:2147	TEST CERT.	√	P	V	-	
5		Special tests if any, explosion proof etc.	Major	TEST	1 Sampl e/Type	-	IS:2148	IS:2148	TEST CERT.	√	P	V	-	
6		Operation Check	Major	TEST	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	
7		Mechanical Interlock	Major	TEST	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	

4.0 PACKING

	PACKING	Soundness of Packing against transit damage	Major	Visual	100%	10%	Approved Packing procedure	Approved Packing procedure	Inspection report	√	P	W	-	
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BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	22/02/24	MEET SAGAR SINGH RAJPAL	Checked by:	Kundan	Kundan						
Reviewed by:	22/2/24	HEMA KUSHWAHA	Reviewed by:		Harish						

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SEC. NO.		DATE:	
			CUSTOMER :					QP NO.: PE-QP-999-558-1001, R05		DATE: 22.02.2024	
			PROJECT:					PO NO.:		DATE:	
			ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS			SYSTEM: STATION LIGHTING SYSTEM		SECTION: II		SHEET 6 OF 6	
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	*	**	
					M B/ C				D	M B C	

NOTES:

1. P/V/- means test will be performed either by lighting fixture supplier or their sub-vendor and verified by lighting fixture supplier
2. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) Indicated in QP shall be referred.
3. Items like ceiling fans, emergency lighting unit, flexible conduit, 24V supply module, ladders, hume pipe, switchboxes, exit signs etc. Will be cleared based on COC (certificate of compliance).

LEGENDS:

*Records, identified with "Tick" (✓) shall be essentially included by supplier in QA Documentation.
 ** M: Supplier/ Manufacturer/ Sub-Supplier, B: Main supplier/ BHEL/ Third Party Inspection Agency, C: Customer,
 P: Perform, W: Witness, V: Verification, as appropriate
 MA: Major, Mi: Minor, CR: Critical, D: Documentation

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No.			
Sign & Date			Name			Seal		Sign & Date		Name	
Prepared by	[Signature]		Checked by	[Signature]				Reviewed by			Seal
Reviewed by	[Signature]		Reviewed by	[Signature]				Approved by			

CHAPTER – 22
CABLING SYSTEM
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CHAPTER – 22

CABLING SYSTEM

22.01.00 SCOPE OF WORK

22.01.01 The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling, fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

- i) TG Building & Transformer Yard.
- ii) Boiler Area, ESP Area, Fuel Oil Area
- iii) Compressor Area
- iv) Chimney
- v) 400kV GIS & 220kV AIS (Extension bays)
- vi) Service Building
- vii) Coal Handling Plant
- viii) Ash Handling Plant
- ix) DM Plant & associated systems
- x) Effluent Treatment Plant
- xi) Sewage Treatment Plant
- xii) Fire Water Pump House
- xiii) CW Pump House
- xiv) Raw Water Area
- xv) Pump House for Dust Suppression System
- xvi) FGD Area
- xvii) Overhead interplant cable trestles, pipe cum cable trestles, cable trench in transformer yard
- xviii) All electrical equipment as described in different sections.
- xix) All auxiliary buildings.

22.01.02 The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

22.02.00 SCOPE OF SUPPLY

22.02.01 The equipment and materials within the scope of supply shall include but not limited to:

- i) Power & control cabling works for electrical and I&C (including that of special cables):
- ii) Galvanized steel prefabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.
- iii) Supply and installation (including laying & termination) of control cables, special cables, I&C cables for all equipment and systems.
- iv) FRP trays with fire retardant corrosion resistance properties and its accessories shall be provided in corrosion prone areas such as Battery



Rooms, Chemical handling area, Water treatment area exposed to corrosive atmosphere.

- v) Supply and installation (including laying & termination) of all power cables (HV, MV and LV) for all equipment and systems.
- vi) Cable routing has to be planned such that it shall not cross the steam lines, oil lines.
- vii) Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.
- viii) Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fireproof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.
- ix) Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.
- x) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- xi) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the Bidder without any extra charge to the Owner.
- xii) Bidder shall arrange all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work.

22.03.00 **CODES AND STANDARDS**

22.03.01 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) mentioned in Chapter 37, the stringent shall prevail..

22.03.02 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. shall also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

22.04.00 **DESIGN AND CONSTRUCTIONAL FEATURES**

22.04.01 Inter Plant Cabling

Interplant cabling for main routes shall be laid along overhead trestles/ pipe racks. However, from tap-offs, same can be through trenches of lengths restricted to 10 metres. Cable trenches are acceptable only in the transformer yard. In case of Duct banks for crossing of railway lines & roads, pull-pits shall



be provided with a PCC covering. Trestles to be provided for routing of cables, pipes etc. shall have a clear height of 8.0m in main plant area, at road/ rail crossings so as to clear the road spaces/ railway lines, approach to maintenance bays of various buildings. A walkway with handrails and toe guards of 600mm (minimum) width shall be provided all along length of the trestle for maintenance of cables and pipes. Ladders for approach to these walkways shall be provided near roads, passageways at suitable locations.

22.04.02 Cable entry

Cable entry from outdoor underground/cable routes to the buildings, if any, shall be above the finished floor level of the building.

22.04.03 Cable Routing

- i) PCC flooring of built-up trenches (provided as per (iv)) shall be sloped for effective drainage with sump pits and sump pumps.
- ii) No subzero level cable vault/trenches shall be provided below control building/switchgear rooms in the entire power plant. A cable spreader room to be provided below all switchgear room and control rooms in all areas.
- iii) All field switches for equipment corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened I&C cables.
- iv) Cable trenches shall be provided only in transformer yard and locally near the equipment having length not more than 10 metres. In GIS hall Cable slit/chase shall be provided.
- v) Two separate cable routes one on each side shall be provided. Cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mills shall be routed in one route & for through other set of auxiliaries through other route.
- vi) Bidder shall provide two independent routes for cables within the Main Plant Building.
- vii) Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays in addition to normal tray cable loadings.
- viii) Cables for pull cord switches, belt sway switches along the conveyors and receptacles in coal conveyors shall be routed in conduits.

22.04.04 Cable Vault:

- i) Cable vault of not less than 3.5 metres clear height shall be provided.
- ii) Clear access passage of at least 800 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways. Wherever the



passage is through cable routes clear height shall not be less than 1.5 Mts.

- iii) Cable vaults shall be provided with adequate drainage facility for drainage of fire water.
- iv) Each cable vault should have two fireproof doors.
- v) Exit signs shall be provided near doors for personnel escape in case of emergency.

22.05.00 EQUIPMENT DESCRIPTION

22.05.01 Cable trays, Fittings & Accessories

- i) Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for HV, MV & LV power & control cables and perforated type for I&C cables. However, in vertical riser's ladder cable trays shall be used for I&C cables also.
- ii) These shall be prefabricated hot dip galvanized sheet steel trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.
- iii) Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm & 150mm may be used in places considering the requirement and space constraint. The trays shall have standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm. Cable tray covers shall be fabricated from 1.6 mm thick MS sheets.
- iv) Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.
- v) Prefabricated hot dip galvanized mild steel cable trays shall be used for maximum support span of 1500 mm. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/75 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.
- vi) The tolerance for cable trays and accessories shall be as per IS 2012 (Part 1). Tolerance Class – Coarse.
- vii) In areas, where acid/alkalie ingration is likely (such as Battery Room, etc.) to occur, Fibre Reinforced Plastic trays with fire retardant corrosion resistance properties shall be used.
- viii) Deflection Test

A 2.5-metre straight section of each type of cable trays shall be simply supported at the two ends. A uniformly distributed load of 100Kg per meter shall be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7mm.

22.05.02 Support System for Cable Trays

- i) Cable tray support system shall be prefabricated similar or equivalent to "Unistrut make".
- ii) Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types:
 - a) C1:- having provision of supporting cable trays on one side and
 - b) C2:-having provision of supporting cable trays on both sides.
- iii) The support system shall be the type described hereunder:
 - a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
 - b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
 - c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
 - d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
 - e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 mm thick rolled steel sheets conforming to IS.
 - f. Cantilever arms of 170mm , 320mm, 470mm and 620mm in length are required for 150mm, 300mm, 450mm and 600mm wide cable trays respectively. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
 - g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover



installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

- h. The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the Bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost. The Bidder shall submit the detailed drawings of the system offered by him along with the bid.

22.05.03 Pipes, Fittings & Accessories

- i) Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria
- ii) GI Pipes shall be of medium duty as per IS: 1239.
- iii) Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.
- iv) Hume pipes shall be NP3 type as per IS 458.
- v) HDPE pipe and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 part-I.
- vi) TERNE Coated Flexible Steel Conduits shall be waterproof and rust proof made of heat resistant lead coated steel. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes and lighting fixtures.

22.05.04 Junction Boxes

- i) Junction boxes shall be of 16 SWG sheet steel hot-dips galvanized, outdoor type, dust vermin and damp proof, generally conforming to IP 55.
- ii) Junction box surface should be such that it is free from crazing, blisters, wrinkling, colour blots / striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished:-
 - a. Impact resistance for impact energy of 2 Joules (IK07) as per BS EN 50102.
 - b. Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.
 - c. HV test
- iii) Junction boxes shall be complete with neoprene gasketed inspection cover, conduit knock out, terminal blocks and painted with one coat of red oxide primer and two finishing coats of synthetic enamel paint shade as mentioned in Chapter 1.



- iv) Junction boxes for outdoor use shall be weatherproof IP-55 and those for hazardous location shall be flame-proof type. Outdoor junction boxes shall be epoxy painted.
- v) Junction boxes shall be of two types viz one suitable for control wiring and the other with terminals for power cable terminations. Junction boxes for power cable terminations shall have minimum nine (9) nos. of terminals. Size of terminals shall be suitable to accommodate cables of sizes as required.
- vi) The junction boxes shall have the following indelible markings:-
 - a) Circuit nos. on top by white-stenciled paint at site.
 - b) Circuit nos. with ferrules (inside) as per approved drawing.
 - c) Danger sign in case of 415 V circuit.
 - d) Junction boxes shall be provided with two Nos. (2) earthing terminals complete with nuts and washers suitable for connection to 8 SWG G.I. wire.

22.05.05 Terminals

Multi-way terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

- i) Each control cable terminal shall be suitable for connection of 2 Nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

22.05.06 Terminations & Straight Through Joints

- i) Termination and jointing kits for 11/6.6 kV grade XLPE insulated cables shall be of proven design. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/6.6 kV grade joints and terminations shall be type tested as per IS: 13573/ IEC 60502. Test reports shall be furnished. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. The kit shall be complete with the copper solder less crimping type cable lugs & ferrule as per DIN standard.
- ii) Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 6.6 kV systems.
- iii) 1.1 KV grade straight through joints shall be of proven design.

22.05.07 Cable Glands

- i) Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 microns. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful Bidder.



- ii) Cable glands shall be double compression type. Glands for classified hazardous areas shall be double compression type flameproof and weatherproof duly certified by CMRS and approved by CCE. Cable glands shall match with the sizes of different HT/LT/Control cables.

22.05.08 Cable Lugs/Ferrules

- i) The cables lugs shall be conforming to IS: 8309.
- ii) Machine ferruling shall be adopted.
- iii) Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.
- iv) The cable lugs for control/I&C/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.
- v) Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types: -
- Copper tubular terminal end for solder less crimping to copper conductors.
 - Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan.
 - Pin type lugs shall not be used.
 - Aluminium tubular terminal ends for solder less crimping of two Aluminium conductor.
 - Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/I&C cables shall be PVC insulated/sleeved type.

22.05.09 Cable Clamps & Straps

- i) The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.
- ii) Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

22.05.10 Galvanizing

- i) Galvanizing of steel components and accessories shall conform to IS: 2629, IS 4759 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.



- ii) The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

22.05.11 Welding

The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

22.06.00 CONSUMABLES AND HARDWARE

22.06.01 The Bidder shall furnish all erection materials, hardware and consumables required to complete the installation.

22.06.02 The materials shall include but not limited to the following:-

- i) Consumables: Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
- ii) Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
- iii) Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

22.07.00 METHODS AND WORKMANSHIP

22.07.01 All work shall be installed in a first class, neat workman like manner by mechanics/electricians skilled in the trade involved.

22.07.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.

22.07.03 All details on installation shall be electrically and mechanically correct.

22.07.04 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

22.08.00 INSTALLATION

22.08.01 Installation work shall be carried out in accordance with good engineering Practices.

22.08.02 Prefabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces shall be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

22.08.03 Cable trays inside buildings shall be aligned and leveled properly. All tray runs shall be installed parallel to the building walls.

22.08.04 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.



- 22.08.05 The cable trays shall be supported in general at a span of not exceeding 1.5 metres horizontally and 1.0 metre vertically.
- 22.08.06 Sufficient spacing not less than 300 mm (Between bottom of the upper tray and top of the lower tray) shall be provided between trays and maintained to permit adequate access, for installing and maintaining the cables.
- 22.08.07 Cable trays in areas subject to oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.
- 22.08.08 Cable tray/conduit system shall be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.
- 22.08.09 Different voltage grade cables shall be laid in separate trays when trays are run in tier formation. Power cables shall normally be on top trays and control/I&C cable on bottom trays.
- 22.08.10 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meters. Risers shall additionally be painted/ stenciled with identification numbers at every floor.
- 22.08.11 In certain cases it may be necessary to site fabricate portions of trays, supports and other non-standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Bidder shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining Owners prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.
- 22.09.00 CONDUITS/PIPES/DUCTS INSTALLATION**
- 22.09.01 The Bidder shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall /cable tunnel/cable trenches made for conduit installation shall be sealed and made waterproof by the Bidder.
- 22.09.02 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.
- 22.09.03 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.
- 22.09.04 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 deg to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for

ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

- 22.09.05 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit / pipe size (dia).	Spacing
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm or above	3.0 M

- 22.09.06 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

- 22.09.07 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Bidder), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Bidder. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the Bidder at no extra cost.

- 22.09.08 In fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc, fire retardant paint to be applied after installation cables.

- 22.09.09 For bending of conduits, bending machine shall be arranged at site by the bidder to facilitate cold bending. The bends formed shall be smooth.

22.10.00 JUNCTION BOXES INSTALLATION

- 22.10.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

22.11.00 CABLE LAYING AND INSTALLATION

- 22.11.01 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays and aligning and leveling as required shall be the responsibility of the Bidder.

- 22.11.02 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case



shall be drum be stored flat i.e., with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

22.11.03 Laying of cables directly buried in ground is not acceptable

22.11.04 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The Bidder shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the Bidder. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

22.11.05 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.

22.11.06 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

22.11.07 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they shall not be subjected to heat from adjacent hot piping or vessels.

22.12.00 LAYING OF CABLES IN CABLE TRAYS

22.12.01 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, Bidder shall route these as directed by the Owner.

22.12.02 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. 11 kV/ 6.6 kV/ 1.1 kV Single core power cable shall be laid in trefoil formation with 2D gap where D is the diameter of the cable and clamped at every two



metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and I&C cables can be laid upto a maximum of three layers in each tray.

- 22.12.03 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/tray with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles.
- 22.12.04 Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five-meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five-meter interval and at every bend.
- 22.12.05 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
- 22.12.06 Individual cables or small groups which run along structures/walls etc shall be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100. They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure shall result.
- 22.12.07 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.
- 22.12.08 Where cables cross rail tracks/roads, the cables shall be laid in Hume pipe/PVC pipe. The hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.
- 22.12.09 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of Owner.
- 22.12.10 **Cable joints are not preferred. Joints shall be allowed as a special case only when the length of the run, in case of single core 11kV UE/ single core 6.6kV UE/ single core LT Power Cable /Control Cable exceeds 1000 metres or 750 metres in case multicore of 11kV UE/6.6kV UE power cables.**
- 22.12.11 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall



have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

- 22.12.12 Wherever few cables are branching out from main trunk route troughs shall be used.
- 22.12.13 Cables shall be neatly arranged in the trenches/trays in such a manner so that crisscrossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Bidder.
- 22.12.14 The Bidder shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical Bidder and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the Bidder. During the erection period the Bidder shall furnish a monthly report on cable position in an approved proforma so as to keep the Owner apprised of the position.
- 22.12.15 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Bidder shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.
- 22.12.16 Electrical cable trays exposed to hazardous process fluid or near oil exposed areas shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.
- 22.12.17 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.
- 22.12.18 Separation
- i) Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.
 - i) At least 300mm clearance shall be provided between:
 - HV power & LV power cables,
 - LV power & LV control/I&C cables,
- 22.12.19 Segregation
- i) Segregation means physical isolation to prevent fire jumping.
 - ii) Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.
 - iii) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in

segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

- iv) In the existing 220kV AIS for the ICT bays control cables of each bay shall be laid on separate cable trays.

22.12.20 Wind loading shall be considered for designing support as well Cable trays wherever required.

22.12.21 Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

22.13.00 CABLE FIRE SEALING

22.13.01 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fireproof sealing system (FPSS) of minimum 2 Hrs rating. The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

22.13.02 Wherever the cables/cable trays pass through walls/floors, fireproof cable penetration seals rated for two hours shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

22.13.03 In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire-Retardant Cable coating compound. Also, the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

22.14.00 Cable laying in trenches

22.14.01 RCC cable trenches with removable covers shall be provided by the Bidder. Cables shall be laid in 3 or 4 tiers in these trenches. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the Bidder at no extra cost.

22.14.02 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

22.14.03 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.

22.14.04 Prior to laying of cables inside both indoor and outdoor trenches, the Bidder shall properly clean inside of those trenches.

- 22.14.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer.
- 22.14.06 Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 22.14.07 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 22.14.08 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 22.14.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit, the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.
- 22.14.10 Following guide of the pipe fill shall be used for sizing the pipe size:-
- a) 1 cable in pipe - 53% full
 - b) 2 cables in pipe - 51% full
 - c) 3 or more cables - 40% full
- 22.14.11 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively, G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.
- 22.14.12 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings shall be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical Bidder shall determine their location and obtain approval of the Site Engineer before cutting is done.
- 22.15.00 CABLE IDENTIFICATION**
- 22.15.01 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Bidder may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.
- 22.15.02 If laying of underground cable is specifically agreed by Owner **as a special case**, then the underground cables shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable

trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription 'Cable Joint'. For buried cables the marker shall project 150mm above ground.

- 22.15.03 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

22.16.00 CABLE TERMINATIONS & CONNECTIONS

- 22.16.01 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer's instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carry out satisfactory cable jointing/termination. Bidder shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.
- 22.16.02 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Site Engineer.
- 22.16.03 Responsibility of proper termination shall lie on the Bidder. Guarantee for termination shall also have to be given by the Bidder.
- 22.16.04 The equipment shall be generally provided with undrilled gland plates for cables/conduit entry. The Bidder shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.
- 22.16.05 Bidder shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the Bidder at the discretion of the Engineer-in-Charge.
- 22.16.06 Control cable cores entering control panel/switchgear /MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self-locking type nylon cable ties with de interlocking facility to keep them in position.
- 22.16.07 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' along with cable numbers and coiled up after end sealing.
- 22.16.08 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
- 22.16.09 It is the responsibility of the Bidder to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

- 22.16.10 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.
- 22.16.11 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.
- 22.16.12 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.
- 22.16.13 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Bidders shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
- 22.16.14 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.
- 22.16.15 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.
- 22.16.16 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.
- 22.16.17 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.
- 22.16.18 Crimping shall be done by hand crimping/hydraulically operated tool and conducting jelly shall be applied on the conductor.
- 22.16.19 Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.
- 22.16.20 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.
- 22.16.21 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least two (2) hours.

22.17.00 Cable accessories for H.V. Systems

22.17.01 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

22.17.02 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the Bidder or the type of cables issued by Owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include connecting ferrules/thimbles all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.

22.17.03 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a) 'PUSH ON' type for LV cables. 'TAPEX' of M-seal make or equivalent for LV cables.

b) Heat-shrinkable sleeve type for MV & HV cables.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

22.17.04 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types:-

a) TAPEX' of M-seal make or equivalent for LV cables

b) Heat-shrinkable sleeve type for MV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of Owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

22.18.00 CLEANING UP OF WORK SITE

22.18.01 The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or driveways.

22.18.02 Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

22.19.00 QUALITY ASSURANCE PROGRAMME

22.19.01 Bidder shall furnish detailed Quality Assurance Program and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.



22.20.00 TESTS**22.20.01 Routine / Acceptance Tests**

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

Routine Tests

- o Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.
- o Physical & dimensional check on all equipments as per approved drawings/standards .
- o HV/IR as applicable.
- o Check/ measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.

Acceptance Test

- Galvanising Tests as per applicable standards
- Welding checks
- Deflection tests on cable trays as per procedure given in 22.05.01 (viii).
- Proof load tests on cable tray support system as per standards.

The above acceptance tests shall be done only on one sample from each offered lot.

Galvanizing Tests

- i) The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.
- ii) Uniformity of coating – The coating of any article shall withstand four 1-minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- iii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.
- iv) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

22.21.00 WELDING

22.21.01 The quality of welding shall be visually inspected, particular attention being paid to the following points:-

- i) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.
- ii) The weld metal shall be properly fused with the parent metal without undercutting.



- iii) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

22.22.00 COMMISSIONING

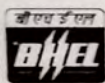
The Bidder shall carry out the following commissioning tests and checks after installation at site. In addition, the Bidder shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance.

Cables

- a. Check for physical damage
- b. Check for insulation resistance before and after termination/jointing.
- c. HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.
- d. Check of continuity of all cores of the cables.
- e. Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the bidder.
- f. Check for correct polarity and phasing of cable connections.
- g. Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
- h. Check for provision of correct cable tags, core ferrules, tightness of connections.

CABLE TRAYS / SUPPORTS AND ACCESSORIES

- a. Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
- b. Check for continuity of cable trays over the entire route.
- c. Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- d. Check for earth continuity and earth connection of cable trays.

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.		DATE:	
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04		DATE: 04.01.2024	
		PROJECT: -NA-		PO NO.:		DATE:	
		ITEM: CABLE TRAYS & ACCESSORIES		SYSTEM: CABLING		SHEET 1 of 3	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B				D	M	B	C	
1.0 RAW MATERIAL														
1.1	HOT ROLLED CARBON STEEL SHEET	1 CHEM & PHY PROPERTIES	MA	VERIFICATION OF TCS	100%	100%	IS -1079	IS -1079	TC	✓	P/V	V	-	
		2 DIMENSIONS	MA	MEASUREMENT	100%	-	IS-1730	IS-1730	QC RECORD		P	-	-	
		3 SURFACE FINISH	MA	VISUAL	100%	-	IS-1079	IS-1079	QC RECORD		P	-	-	
1.2	ZINC	CHEM COMP	MA	CHEM TEST	EACH HEAT	EACH HEAT	IS-209	IS-209	TC	✓	P/V	V	-	
2.0 IN-PROCESS														
2.1	FABRICATION	1 DIMENSIONS	MA	MEASUREMENT	100%	100%	APPD DOCUMENT ASME SEC. IX	APPD DOCUMENT ASME SEC. IX	QC RECORD	✓	P	V		
		2 WELDING QUALITY	MA	VISUAL	100%	100%			QC RECORD	✓	P	V		Welding is to be done by qualified welders in accordance with ASME SEC. IX article III WPS, PQR & WPI to be reviewed during inspection.
		3 SURFACE FINISH	MA	VISUAL	100%	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	✓	P	V	-	
2.2	SURFACE PREPARATION	1 CLEANING, PICKLING & RINSING & FLUXING	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	
		2 SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
Sign & Date	Name		Sign & Date	Name	
Checked by: <i>Mantoo</i>	<i>MANJUS MEENA</i>	Checked by: <i>Mantoo</i>	<i>Mantoo</i>	<i>Mantoo</i>	
Reviewed by: <i>He</i>	<i>HEENA</i>	Reviewed by: <i>He</i>	<i>He</i>	<i>Heena</i>	
by: <i>He</i>	<i>KUSHWAHA</i>	by: <i>He</i>	<i>He</i>	<i>Heena</i>	

23/2/24

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.:	DATE:
		ITEM: CABLE TRAYS & ACCESSORIES	SYSTEM: CABLING		SHEET 2 of 3

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	* D	**			
					M	B					M	B	C	
23	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	MEASUREMENT	CONTINUOUS	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	Galvanization is to be done at galvanization plant listed in Annexure-1 to quality plan.
		2.DROSS	MA	VISUAL	PERIODIC	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, ROUGHNESS, SLAG FLUX, STAIN ETC.	QC RECORD		P/V	-	-	

3.0 FINISHED ITEMS

3.1	(CABLE TRAY, ACCESSORIES &)	1. DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DOCUMENT	INSP. REPORT	✓	P	W	-	
		2. SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN ETC.	INSP. REPORT	✓	P	W	-	
		3. RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	05 No./ LOT/	05 No./ LOT/	APPD. DRG	APPD. DOCUMENT	INSP. REPORT	✓	P	W	-	600MM wide Ladder & perforated cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
Sign & Date	Name		Sign & Date	Name	
Checked by: <i>Mund</i>	MANOJ MEENA		Checked by: <i>Manoj Meena</i>		
Reviewed by: <i>HEWA</i>	HEWA RUSHWA		Reviewed by: <i>Manoj</i>		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO.	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.:	DATE:
		ITEM: CABLE TRAYS & ACCESSORIES	SYSTEM: CABLING	SHEET 3 of 3	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
1	2	3	4	5	6		7	8	9	* D	**			
					M	B					M	B	C	
3.0 FINISHED ITEMS														
		4 MASS OF ZINC COATING	MA	CHEM TEST	IS-4759	IS-4759	IS-6745	APPD DOCUMENT	INSP REPORT	✓	P	W	-	
		5 UNIFORMITY OF ZINC COATING	MA	CHEM TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP REPORT	✓	P	W	-	
		6 THICKNESS OF ZINC COATING	MA	PHYSICAL TEST	IS-4759	IS-4759	APPD DOCUMENT	APPD DOCUMENT	INSP REPORT	✓	P	W	-	
		7 ADHESION	MA	MECH TEST	IS-4759	IS-4759	IS-2629	IS-2629	INSP REPORT	✓	P	W	-	
		8 COUPLER PLATE	MA	VISUAL	100%	100%	APPD DOCUMENT	APPD DOCUMENT	INSP REPORT	✓	P	W	-	
		9 NUT & BOLT	MA	VISUAL	100%	100%	APPD DOCUMENT	APPD DOCUMENT	INSP REPORT	✓	P	W	-	Inspector to mention the total number of bags/bundles of coupler plates, nuts, bolts & washer in the inspection report.
		10 WASHER	MA	VISUAL	100%	100%	APPD DOCUMENT	APPD DOCUMENT	INSP REPORT	✓	P	W	-	further manufacturer shall attach the detail of total number of bags/bundles of the respective items with packing list.
		11 PACKING	MA	VISUAL	100%	100%	APPD DOCUMENT	APPD DOCUMENT	INSP REPORT	✓	P	V	-	

NOTES:

1. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. D: DOCUMENTATION

** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,

P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE. MA: MAJOR, MI: MINOR, CR: CRITICAL.

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL			
ENGINEERING		QUALITY	
Sign & Date	Name	Sign & Date	Name
Checked by: <i>M. S. S.</i>	<i>MAHES</i>	Checked by: <i>H. S. S.</i>	<i>M. S. S.</i>
Reviewed by: <i>J. S. S.</i>	<i>MAHES</i>	Reviewed by: <i>A. S. S.</i>	<i>H. S. S.</i>

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013		DATE:	
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03		DATE: 04.01.2024	
		PROJECT: -NA-		PO NO.: -NA-		DATE:	
		ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE		SYSTEM: CABLING		SHEET 1 OF 4	

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	M	B	C	
					M	B								
1.0 RAW MATERIAL														
11	ROLLED CARBON STEEL SHEET	1 CHEM. & PHY PROPERTIES	MA	VERIFICATION OF TC'S	100%	-	IS1079 (for hot rolled) IS-513 (for cold rolled)	IS1079 (for hot rolled) IS-513 (for cold rolled)	TC		P	-	-	
		2 DIMENSIONS	MA	MEASUREMENT	100%	-	IS-1730/	IS-1730	QC RECORD		P	-	-	
		3 SURFACE FINISH	MA	VISUAL	100%	-	IS1079 (for hot rolled) IS-513 (for cold rolled)	IS1079 (for hot rolled) IS-513 (for cold rolled)	QC RECORD		P	-	-	
12	ZINC	CHEM. COMP.	MA	CHEM. TEST	EACH HEAT	-	IS-209	IS-209	QC RECORD	√	P/V	V	-	
2.0 IN-PROCESS														
21	FABRICATION	1. DIMENSIONS	MA	MEASUREMENT	100%	-	APPD. DRG	APPD. DRG	QC RECORD	√	P	V	-	
		2. WELDING QUALITY	MA	VISUAL	100%	-	ASME SEC. IX	ASME SEC. IX	QC RECORD	√	P	V	-	Welding is to be done by qualified welders in accordance with ASME Sec IX article III, WPS, PQR and WPQ to be reviewed during inspection

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
Checked by:	Sign & Date	Name	Checked by:	Sign & Date	Name
Reviewed by:			Reviewed by:		

22/2/24

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			



	MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.: -NA-	DATE:
		ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 2 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	B					M	B	C	
		3 SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	√	P	V	-	
2.2	SURFACE PREPARATION	1. CLEANING, PICKLING & RINSING & FLUXING	MA	MEASUREMENT	PERIODIC IN EACH SHIFT	-	IS-2629	IS-2629	QC RECORD		P	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS-2629	IS-2629	QC RECORD		P	-	-	
2.3	GALVANISING	1. TEMPERATURE OF BATH	MA	MEASUREMENT	CONTINUOUS	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	Galvanization is to be done at galvanization plant listed in Annexure-I to quality plan.
		2. DROSS	MA	VISUAL	PERIODIC	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	
		3. RATE OF IMMERSION	MA	VISUAL	100%	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS-2629	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN ETC.	QC RECORD		P/V	-	-	

BIDDER/SUPPLIER

Sign & Date
Seal

BHEL			
ENGINEERING		QUALITY	
	Sign & Date	Name	
Checked by:		MANOJ MEENA	Checked by:
Reviewed by:		HEMA RUSHWAHA	Reviewed by:
			22/12/24

FOR CUSTOMER REVIEW & APPROVAL.

Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.: -NA-	DATE:
		ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 3 OF 4

SL NO.	COMPONE NT & OPERATIO NS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENC E DOCUMEN T	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	B					M	B	C	
3.0 FINISHED ITEMS														
3.1	SINGLE / DOUBLE CHANNELS, CANTILEVER ARMS, CLAMPS	1 DIMENSIONS	MA	MEASUREME NT	IS-2500 (PART-1) LEVEL S-4	IS-2500 (PART-1) LEVEL S-4	APPD.DRG	APPD.DRG	INSP REPORT	√	P	W		
		2 SURFACE FINISH	MA	VISUAL	IS-2500 (PART-1) LEVEL S-4	IS-2500 (PART-1) LEVEL S-4	APPD.DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN ETC.	INSP REPORT	√	P	W		
		3 MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-6745/ APPD.DRG	APPD.DRG	INSP REPORT	√	P	W		
		4 UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP REPORT	√	P	W		
		5 THICKNESS OF ZINC COATING	MA	MEASUREME NT	IS-4759	IS-4759	APPD.DRG	APPD.DRG	INSP REPORT	√	P	W		
		6 ADHESION	MA	MECH.TEST	IS-4759	IS-4759	IS-2629	IS-2629	INSP REPORT	√	P	W		
3.1.1	TYPE TESTING	PHYSICAL	CR	TEST	1 SAMPLE*	1 SAMPLE*	APPD. TYPE TEST PROCEDURE	APPD. TYPE TEST PROCEDURE	INSP REPORT	√	P	W		*1 sample per / offered quantity

BIDDER/SUPPLIER

Sign & Date

Seal

BHEL

ENGINEERING

Sign & Date

Checked by: *Mang*

Reviewed by: *Heu*

Name

MAHES MEENA

HEERA

Checked by:

Reviewed by:

RUSHWANI

FOR CUSTOMER REVIEW & APPROVAL

QUALITY

Sign & Date

Checked by: *Adithy*

Reviewed by: *Mintoo*

Name

22/2/24

Doc No:

Sign & Date

Reviewed by:

Approved by:

Name

Seal

	MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.: -NA-	DATE:
		ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 4 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASSES	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9		M	B	C	
					M	B								
3.1.2	WELD INTEGRITY TEST	SOUNDNESS	CR	MAGNETIC PARTICLE INSPECTION (MPI) DIE-PENETRATION (DP)	SAMPLE TESTD DURING TYPE TESTIN G	SAMPLE TESTED DURING TYPE TESTING	APPD. TYPE TEST PROCEDURE	NO DEFECT	INSP REPORT	✓	P	W	-	AFTER CARRYING OUT TYPE TEST, WELD INTEGRITY TEST TO CHECK THE WELD SOUNDNESS/ ACCEPTANCE SHALL BE DONE BY MANUFACTURER
4.0	PACKING	SEALING IDENTIFICATION	MA	VISUAL	100%	100%	BHEL APPD. DOCUMENT	BHEL APPD. DOCUMENT	INSP REPORT	✓	P	W	-	

NOTES:

1. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, D: DOCUMENTATION

** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,

P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE

MA: MAJOR, MI: MINOR, CR: CRITICAL

BIDDER/SUPPLIER		BHEL		FOR CUSTOMER REVIEW & APPROVAL			
Sign & Date		ENGINEERING		QUALITY		Doc No:	
Seal		Checked by: <i>Mishra</i>	Name: <i>MANOJ</i>	Checked by: <i>Mishra</i>	Name: <i>Mintoo</i>	Reviewed by:	Sign & Date
		Reviewed by: <i>Heu</i>	Name: <i>MEENA</i>	Reviewed by: <i>Heu</i>	Name: <i>Harsh</i>	Approved by:	Name
			Name: <i>KUSHWAHA</i>				Seal

CHAPTER – 26
EARTHING & LIGHTNING PROTECTION

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CHAPTER – 26
EARTHING & LIGHTNING PROTECTION**26.01.00 GENERAL**

This specification is intended to cover the design, engineering, manufacture, assembly, testing at manufacturer's works, supply in properly packed condition for transport to site and delivery Grounding and Lightning system complete with all accessories for efficient and trouble-free operation.

26.02.00 CODES AND STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as mentioned in Chapter 37 except where modified and/or supplemented by this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments. All work shall be carried out as per applicable codes and standards.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, VDE etc. shall also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments.

26.03.00 GROUNDING & LIGHTNING PROTECTION**26.03.01 General**

The main objectives of grounding system are to:

- a) Provide safety to personnel from contact of dangerous potential caused by ground fault.
- b) Ensure sufficient grounding current for effective relaying.
- c) Stabilize circuit potential with respect to ground.
- d) Bidder shall carry out earth resistivity test of power project site within battery limit and shall establish homogeneous soil resistivity for earthing design. Number of earth resistivity test locations shall be not less than 15. The test locations shall be subject to Owner's approval.
- e) Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.
- f) Bidder to submit the earthing layout drawings including earth mat, lightning protection layout drawing, detailed design and calculations, etc., for Owner's approval.

26.03.02 Grounding system

- i) In order to meet the above objectives, symmetrical ground grid mesh shall be provided for the entire area within battery limit.
- ii) Fault current for the earthing system shall be designed for 63 KA for duration of 1 sec in GIS and 50 kA for duration of 1 sec in other areas.



- iii) All electrical equipment, non-current carrying metal parts, structures, building steel, lightning protection system, transformer neutrals shall be connected to this station ground grid.
- iv) Treated earth pits including riser shall be provided for Transformer neutral earthing.
- v) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.
- vi) Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

26.03.03 **Ground Grid Conductor**

- i) Ground grid conductor of mild steel rod shall be used.
- ii) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the steel corrosion (by soil) loss of 0.12 mm (on diameter of conductor) per year over the design life of 40 years.

26.03.04 **Underground Grid**

- i) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE 665 and touch voltage & step voltage is to be calculated considering weight of person 50 Kg.
- ii) The ground grid conductors shall be buried in earth at a depth of 600 mm. However suitable precaution to be taken wherever underground drains / Trenches are passing through it. The length of ground conductors below earth shall be sufficient to ensure a ground resistance less than one (1) ohm for each area/building. For electronic earthing system shall be less than 0.5 ohms.
- iii) The ground grid conductor shall be so laid as to provide short and direct connection to building steel and major electrical equipment.
- iv) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.
- v) All ground grid conductor connections shall be welded type.
- vi) Earth mat of each area/building (ie Main Plant Building, Transformer Yard, Service Building, DG Building and CPU Regeneration building etc.) shall be interconnected with the earth mat conductor of the neighboring area at least two (2) points for further reducing the ground grid resistance.
- vii) A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.
- viii) In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the

grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

- ix) Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.
- x) Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.
- xi) The Bidder shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc.

26.03.05 **Ground Electrode**

Ground electrodes shall be 40 mm dia. and 3-metre-long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductors. All connections to the conductors shall be done by arc welding process.

26.03.06 **Above Ground Connections**

- i) Galvanised steel flats shall be used for all connections above earth.
- ii) Inside building, ground conductors shall be run for each floor supported on building steel and/or cable trays. These ground conductors in turn shall be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.
- iii) Two separate and distinct ground connections shall be provided for each electrical equipment in compliance with I.E. Rules.
- iv) All connections above ground shall be welded type except connection to equipment/structures which shall be bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti-corrosive paint/compound.

26.03.07 **Column Grounding**

All steel columns and structures shall be connected to the earth mat through 40 mm dia M.S. rods. All welded joints shall be painted to protect from rusting.

26.03.08 **Risers**

Risers are required for connecting the equipment and structures with the ground mat. Risers are to be provided from underground mat to above ground levels where the ends shall be left free for connecting to the equipment. Each riser shall be 40 mm dia. M.S. rod and shall project above grade level/concrete floor level by minimum 300 mm. They are to be clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding. Number of risers shall be as per system requirement.



Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose.

26.03.09

Equipment Ground Lead

- i) Equipment ground connections shall be sized to carry the ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.
- ii) The minimum ground conductor sizes for various equipment and structures are given in below.

DESCRIPTION	SIZE	MATERIAL
a) Main Grounding Grid Conductor	40 mm dia Rod	Mild Steel
b) Riser/Pigtail From Grounding Grid/Mat	40 mm dia Rod	Mild Steel
c) Electrode	40 mm dia, 3000 mm long Rod	Mild Steel
Conductor used for connection of various equipment/structures as listed below		
i) TGs, GTs, UATs and IPBD	75 x 10 mm	GI Flat
ii) Transformer body	75x10 mm	GI flat
iii) 11 kV & 6.6 kV Switchgears, Motors	75 x 10 mm	GI Flat
iv) 415V Switchgear, MCCs, Battery Charger, distribution Boards	75 x 10 mm	GI Flat
v) Sub-mat	75 x 10 mm	GI Flat
v) Segregated and Non segregated Phase Busduct	75 x 10 mm	GI Flat
vi) Gen VT panel	75 x 10 mm	GI Flat
vi) 415 Motors		
1) Above 100 KW upto 200 KW	75x10 mm	GI Flat
2) Above 55 KW up to 100 KW	40x6 mm	GI Flat
3) Above 22 KW up to 55 KW	40x6 mm	GI Flat
4) Above 5.5 KW up to 22 KW	25 x 6 mm	GI Flat
5) Up to 5.5 KW	4 SWG	GI Wire

DESCRIPTION	SIZE	MATERIAL
vii) Cable Trays	40 x 6 mm	GI Flat
viii) Control Panel & Control Desks etc.	40 x 6 mm	GI Flat
ix) Steel Column	75 x 10 mm	GI Flat
x) Fence and Gate	40 x 6 mm	GI Flat
xi) Push Button Stations	8 SWG	GI Wire
xii) Lighting panel, Junction Boxes	4 SWG	GI Wire
xiii) System neutrals (for service transformers)	1Cx400 sq.mm	XLPE cable
xiv) Lighting Fixtures & Receptacles	14 SWG	GI Wire
xv) Welding Outlets	8 SWG	GI Wire
xvi) Rails	40 x 6 mm	GI Flat

- iii) 75 x 10 mm galvanized steel flats(minimum size) shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing. These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground. Earthing conductors along their run-on column, wall etc. shall be supported by suitable welding/clamping at intervals not exceeding 750 mm.
- iv) Earthing conductors can be embedded in concrete floor of the building wherever necessary without having direct contact with the reinforcement rods. At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves. Earthing conductor embedded in the concrete floor of the building shall have approximately 50mm concrete cover.
- v) All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.
- vi) Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.
- vii) Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.

- viii) A continuous 40 x 6 mm (minimum size) G.S. flat earthing conductor shall run along the cable trays and supporting structure of all cable routes. This earthing conductor shall be attached to each section of cable tray/trays through 40 x 6 mm G.S. flats. The earthing conductor shall be securely connected to the earth mat at both ends. The distance between earthing points shall not exceed 30 metres.
- ix) Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.
- x) The street lighting poles, junction boxes mounted on the poles, flood light supporting structures etc. shall be connected to ground grid at minimum two points.
- xi) The steel columns, metallic stairs, handrail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.
- xii) The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.
- xiii) The overhead crane rails shall be grounded at both ends. In addition, all joints shall be bonded to provide electrical continuity.
- xiv) The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.
- xv) The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

26.03.10 Jointing and Connection

- i) All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.
- ii) The bending of the large diameter ground conductor where necessary shall be done by gas heating.
- iii) The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.
- iv) The connections between the riser/pigtail and earthing conductors (galvanized steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.



- v) The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.
- vi) The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GS bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.
- vii) Equipment/structures ground connections shall be coated with weather resistant paints/cold galvanizing paints after proper checking / testing.
- viii) Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

26.04.00 EARTHING OF CABLING SYSTEM

- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
- Armour of other cables shall be earthed at both ends of cable.
- Screen of HT power cables shall be earthed at one end only.
- Screen of C&I screened control cables shall be earthed at one end.
- Screen of electronic earthing system cables shall be earthed as per the requirements.

After completion of grounding system installation, the measurement of ground resistance shall be performed by the Bidder. Continuity of earth conductors and efficiency of all bonds and joints shall be checked. The method of measurement shall be as per relevant standards / codes. The ground resistance of system shall be not more than the values mentioned in CI 26.03.04 (ii). Earth resistance at earth terminations shall be measured in presence of Owner's representatives

26.05.00 GENERAL

- i) Electronic earthing shall be provided as per relevant international standard for all control systems (such as DDCMIS, PLC, SAS, EDMS etc.,) For electronic equipment chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 4000 mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be of copper
- ii) Neutral of Service transformers shall be earthed through minimum of 400 sq mm single core cable through two numbers treated earth pit and in turn shall be connected to station earth grid.
- iii) LV Neutral Points of the following transformers shall be connected to Neutral Grounding Resistors (NGRs). NGR shall be connected to earth through two numbers treated earth pit.



- Unit transformer
 - Station Transformer
 - Unit auxiliary transformer
 - Station auxiliary transformer
 - Other auxiliary transformers
- iv) Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- v) Earthing conductors along their run-on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals not exceeding 750 mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- vi) Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.
- vii) Electronic panels and equipment shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrode.

26.06.00 **EARTHING OF CHIMNEY**

- 26.06.01 Earth grid system for chimney shall consist of horizontal conductors and vertical conductors. Horizontal conductor shall be of 40mm dia mild steel rod buried at a depth of 1 metre all around the chimney. Vertical rods shall be of 40 mm dia, 3-metre-long mild steel driven deep into the ground and also connecting to horizontal conductor at 20 metre intervals. The chimney earth grid system shall be interconnected with main plant earth grid at minimum 2 points, through bolted removable link and earth pits.
- 26.06.02 Steel structures, metallic pipes etc. shall also be connected to earthing system. Connections between earthing conductor and equipment shall be of bolted type only. Earthing conductors along their run-on walls shall be supported by cleating at 1 metre interval. Clamps and hardware shall be of compatible material.
- 26.06.03 Metallic enclosures of all electrical equipment shall be earthed by two separate and distinct connections to earth grid system. The earth connections shall consist of galvanized steel strip/rod/wire, sized adequately to carry the earth fault current of the system. Two nos. main earthing conductor shall be run inside all along chimney height. Electrical equipment at every platform shall be earthed with this conductor. Cable armour shall be bonded to earthing system at both ends of the circuit. The earthing conductors and accessories located at top 12m level shall have lead cover of minimum 2mm thickness. The accessories like nuts, bolts, dash fasteners, round clamps, washers etc. to be used for top 12m level shall be made of stainless steel.
- 26.06.04 The minimum size of earthing conductor shall not be less than 14 SWG G.S wire. Earthing conductor shall also be run along with cable ways / each conduit run.
- 26.06.05 The Bidder shall provide and maintain a temporary earthing system until permanent earthing system is installed

26.07.00 LIGHTNING PROTECTION SYSTEM

- i) The main purposes of lightning protection system are to:
 - a) Provide protection to structures from lightning strokes.
 - b) Provide a low resistance-conducting path to lightning discharge.
- ii) Lightning protection shall be provided as per IS: 2309/ IEC 62305/ latest IS Standards for the structures, equipment and buildings.

26.07.01 System Design

- i) Air termination network with down conductors and earthing electrodes shall be provided on the basis of IS Code of Practice.
- ii) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.
- iii) Down conductors shall run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.
- iv) An earth electrode shall be provided at the connection point of the down conductor with the station ground.
- v) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.
- vi) Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
- vii) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.
- viii) The lightning protection system in the transformer yard /AIS shall cover the following equipment in the protection zone.
 - Generator transformers
 - Station transformers
 - Auxiliary transformers
 - ICT
 - Main Bus I
 - Main Bus II
- ix) Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.
- x) For Lightning protection, material Thickness of galvanising shall be at least 610 gm/sq.m for all Galvanised steel conductors.
- xi) The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical



equipment, underground metallic ducts etc. All metallic structures within vicinity shall be bonded to the lightning protection system.

- xii) All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.
- xiii) Lightning conductor on roof shall be cleated on surface of roof using insulated clamps/saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run.

26.07.02 Air Terminations

- i) The vertical air terminal rods shall be installed at the roof of buildings for MCC/Switchgear rooms, ESP Control rooms etc to protect these objects from lightning strokes.
- ii) The projected length of the Air termination rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.
- iii) The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.
- iv) All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 25 x 6 mm galvanized steel flats. Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rod shall be more than nine (9) metres from the nearest roof conductor.

26.07.03 Shielding Masts

- i) The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of the associated building.
- ii) The shielding mast shall be made of galvanized steel rod and the height of the same shall be decided considering the zones to be protected.
- iii) Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm minimum. Galvanised steel flat run along the building column. In addition, all building columns joints shall be electrically bonded.

26.07.04 Down Conductors

- i) Galvanized steel down conductors of suitable size shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.
- ii) Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.
- iii) At all supports for down conductor along the column/wall of the buildings etc. the portion embedded inside the building concrete should not touch the reinforcement bars.



- iv) All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.
- v) The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

26.07.05 Electrodes (for Lightning Protection)

- i) The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.
- ii) All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid underground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

26.07.06 Riser (for Lightning Protection)

All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

26.07.07 Jointing & Connection

- i) All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.
- ii) The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.
- iii) The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.
- iv) All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.
- v) The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.
- vi) The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.
- vii) The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).
- viii) The steel to copper connection shall be brazed type.
- ix) The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air

terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

- x) The sizes and materials of earthing conductors to be used in lightning protection system are listed below:-

DESCRIPTION	SIZE	MATERIAL
1) Horizontal air termination and down conductors for buildings, boilers and other tall structures except Chimney & NDCT.	25 x 6 mm	GI Flat
2) Vertical air termination rods for other buildings / tanks etc except Chimney.	20 mm dia 1000 mm long	MS rod

Note: The above sizes are indicative only. Actual size shall be arrived at as per design by the Bidder.

26.07.08 Lightning Protection of Chimney

Lightning protection system shall conform to IEC:60203. It shall comprise vertical air termination, horizontal air termination, down conductor, test links, earth connections and earth electrodes.

Vertical air termination shall extend 3 M above the top of the chimney. For each flue duct, 3 nos. vertical air terminations shall be provided. Vertical air termination shall be of 20mm dia copper rod with lead cover of 2 mm thickness.

Horizontal air terminations(coronal bond) shall be of minimum 50x6 mm galvanized steel strips provided at top level of the flue, roof top level around outer concrete shell and at mid height around concrete shell.

Horizontal air terminations and vertical air terminations shall be interconnected by down conductors. No. of down conductors shall be as per IS: 62305 or minimum 4 (whichever is higher), equally spaced around and on exterior surface of concrete shell. Down conductors shall be of minimum 50x6 mm galvanized steel strip. Down conductors shall additionally be connected to vertical reinforcement rods at top and bottom of chimney at minimum four locations. Suitable precaution shall be taken at these joint connections to prevent any galvanic action. Reinforcement bars shall be made electrically continuous throughout their height

Each down conductor shall be provided with a test link at 1 M above ground level. Each test link shall be enclosed in a galvanized sheet steel enclosure

Below the test link, direct connection with 40 mm dia mild steel rod shall be made to the earth grid system. Adequate no. of vertical electrodes of 40mm dia mild steel shall be provided to obtain required earth resistance of less than one (1) ohm.

Down conductors shall not be connected to other earthing conductors above ground level. To avoid side flashing, metallic structures like handrails, stairs etc.in the vicinity of down conductor shall be bonded to lightning protection system

Air terminations, down conductors, coronal band and accessories located at top 12 m level shall have lead cover of 2mm thickness. Suitable bimetallic washers shall be used while connecting conductors of different materials. The accessories like nuts, bolts, dash fasteners, round clamps, washers etc., to be used for top 12 M level shall be made of stainless steel.

Down conductors and horizontal air terminations shall be cleated to concrete structure at 750 mm interval.

The Bidder shall provide and maintain a temporary lightning protection system until permanent lightning protection system is installed.

26.07.09 **Lightning Protection of NDCT**

Pointed vertical air terminal rods shall be provided at the top and these shall be spaced around the circumference of the top. Air terminals shall consist of galvanized steel conductors, each not less than 20 mm diameter, projecting not less than 750 mm above the highest part structure. Air terminals shall be mechanically and electrically connected to a continuous circumferential conductor. Number of down conductors as per IS: 62305, shall be located along the exterior wall (equally spaced), shall extend to the base to earth electrode pit, and shall be connected to the power station earth grid.

The Bidder shall provide and maintain a temporary lightning protection system until permanent lightning protection system is installed.

26.08.00 **TESTS**

26.08.01 Routine Tests

Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.

Physical & dimensional check on all equipment as per approved drawings/ standards.

Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.

26.08.02 Acceptance Test

Galvanising check as per applicable standards.

26.09.00 **COMMISSIONING**

The Bidder shall carry out the following commissioning tests and checks after installation at site. In addition, the Bidder shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance.

Earthing continuity checks.

Earthing resistance of the complete system as well as sub system.

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN					SPEC. NO:		DATE:	
			CUSTOMER:					QP NO.: PE-QP-999-509-E001, R3		DATE:	
			PROJECT:					PO NO.:		DATE:	
			ITEM: ABOVE GROUND EARTHING MATERIALS			SYSTEM: EARTHING				SHEET 1 OF 2	

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	*	**
					M	B			D	M B C

1.0	RAW MATERIAL:													
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION OF TC'S	100%	-	IS 2062	IS 2062	MILL TC	✓	P	V	-	REFER REMARKS AT SL. NO. 3.1
		2. DIMENSIONS	MA	MEASUREMENT	100%	-	IS 1730	IS 1730	QC RECORD	✓	P		-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	IS 1079	IS 1079	QC RECORD	✓	P		-	
1.2	ZINC	1.CHEMICAL COMP.	MA	CHEM. TEST	SAMPLE	-	IS 209	IS 209	QC RECORD	✓	P	V	-	
2.0	IN PROCESS:													
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	-	IS 1730	IS 1730	QC RECORD	✓	P	V	-	
2.2	SURFACE PREPARATION	1. CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	MEASUREMENT	CONTINUOUS	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		2. DROSS	MA	VISUAL	PERIODIC	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	GALVANIZATION IS TO BE DONE AT GALVANIZATION PLANT LISTED IN ANNEXURE-1 TO QUALITY PLAN.
		3.RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN	QC RECORD	✓	P	-	-	
3.0	FINISHED ITEMS:													
3.1	MS FLATS	1. CHEMICAL COMP.	MA	CHEM. TEST	1 No./LOT/SIZE	-	IS 2026	IS 2026	LAB TC	✓	P	V	-	NOTE: SAMPLE FOR CHEMICAL TEST SHALL BE SELECTED BY BHEL& TESTING SHALL BE DONE AT NABL/ GOVT. APPD. LAB
		2. DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	IS 1730	IS 1730	INSPECTION REPORT	✓	P	W		

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
Sign & Date	Name	Sign & Date	Name	Sign & Date	Name
Checked by: <i>[Signature]</i>	MANJUS MEENA	Checked by: <i>[Signature]</i>	Suman	Reviewed by: <i>[Signature]</i>	Hain
Reviewed by: <i>[Signature]</i>	Sandeep	Reviewed by: <i>[Signature]</i>		22-2-24	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN				SPEC. NO:		DATE:	
			CUSTOMER:				QP NO.: PE-QP-999-509-E001, R3		DATE:	
			PROJECT:				PO NO.:		DATE:	
			ITEM: ABOVE GROUND EARTHING MATERIALS		SYSTEM: EARTHING				SHEET 2 OF 2	

Sl No.	COMPONENTS & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	* D	** M B C
					M B					

		3. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	-	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	✓	P	W	
		4. MASS OF ZINC COATING	MA	CHEM. TEST	IS 4759	IS 4759	IS-6745	FLATS 5 MM THICK AND OVER 610 GM/SQ.M. FLATS UNDER 5 MM, BUT NOT LESS 2 MM 460 GM/SQ.M.	INSP. REPORT	✓	P	W	-
		5. UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP. REPORT	✓	P	W	-
		6. THICKNESS OF ZINC COATING	MA	MEASUREMENT	IS-4759	IS-4759	IS-4759	FLATS 5 MM THICK AND OVER=AVG 86 MICRON AND MINIMUM 75 MICRON. FLATS UNDER 5 MM THICK, BUT NOT LESS 2 MM =AVG 65 MICRON	INSP. REPORT	✓	P	W	-
		7. ADHESION	MA	MECH. TEST	IS-4759	IS-4759	IS 2629	IS 2629	INSP. REPORT	✓	P	W	-

NOTE: ITEMS LIKE PIPES/ FLEXIBLE COPPER BRAID/ GI WIRE/ GS ROD/ SHIELDING MAST/ TEST LINK WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE)

4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	BHEL APPROVED DOC	BHEL APPROVED DOC	INSP. REPORT	✓	P	V	-
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NOTES:

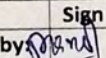
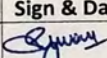
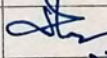
- LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(V) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, D: DOCUMENTATION
C: CUSTOMER, P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE MA: MAJOR, MI: MINOR, CR: CRITICAL

** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: BHEL/ THIRD PARTY INSPECTION AGENCY,

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEENA	Checked by:		Suman
Reviewed by:		Sandeep	Reviewed by:		Harish

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

CHAPTER – 20
LV POWER CABLES
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CHAPTER – 20
LV POWER CABLES**20.01.00 SCOPE OF SUPPLY**

20.01.01 The LV Power cables shall be supplied, installed and commissioned in accordance with the following specification.

20.02.02 Other cables including special cables if any which are necessary as per proven engineering practice for satisfactory & trouble-free operation of the entire cable system of the power plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

20.02.00 CODES & STANDARDS

20.02.01 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on zero date. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the standards listed in Chapter 37.

20.02.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted subject to approval of the Owner. In such case, copies of the English version of the standards adopted shall have to be submitted along with the bid.

20.02.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations applicable to the work shall be followed.

20.03.0 DESIGN CRITERIA

20.03.01 The cables shall be used for connection of power circuits of the system. Actual cable sizes shall be selected based on approved sizing calculations. Number of different sizes selected shall be kept to a minimum for optimization. Preferred cable sizes are mentioned in Annexure A.

20.03.02 Cables shall be generally laid on ladder type cable trays. For interplant connection cables shall be routed along overhead cable bridge.

20.03.03 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification.

20.03.04 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

20.03.05 The inner and outer sheath shall have flame retardant low smoke (FRLSH) characteristics or fire survival characteristics as the case may be and shall meet the requirements of additional tests specified for the purpose.

20.03.06 Core identification for multicore cable shall be provided by colour coding.

- 20.03.07 Cables shall be so designed and manufactured that no damage occurs during handling, transit, storage, installation under any operative conditions which they may be subjected to.
- 20.03.08 Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.
- 20.03.09 Power cables shall be chosen taking into account the factors mentioned in Chapter -1.
- 20.04.00 **SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS**
- 20.04.01 1.1KV Aluminium Conductor Power Cables
- i) 1100 volt, 90 Deg. C rating, heavy duty power cables with stranded aluminium conductor, extruded XLPE insulation, extruded PVC,FR-LS inner sheath, aluminium round wire armour for single core cables and galvanized steel strip /wire armour for three (3) core cables, and extruded PVC, FR-LS overall sheath. Cables shall be manufactured in conformity to IS-7098 part 1 - 1988, amended up to date and bearing ISI mark.
 - iii) Conductor
The cable conductor shall be made from standard Aluminum of grade H2 and Class 2 to form compact conductor having a resistance within the limits specified. All the cables of size 25mm² and above shall have sector shaped conductors.
 - iv) Insulation
The insulation shall be XLPE type. It shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The insulation of the cables shall be of high standard quality.
 - v) Inner Sheath
 - a) The laid up insulated cores of twin and multicore power cables shall be provided with an inner sheath of extruded FRLSH PVC, compound conforming to Type ST2 of IS:5831. Single core power cables need not be provided with any inner sheath.
 - vi) Armour
 - a) For single core armoured cables, armouring shall be of aluminium wires/formed wires of H4 grade.
 - b) For multicore armoured cables, armouring shall be of galvanised steel strip /wire.

vii) Overall Sheath

- a) Outer sheath shall be of extruded FRLSH PVC compound conforming to type ST2 as per IS: 5831 & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall be applied with anti rodent and termite additives. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLSH properties.
- (i) Oxygen index of min. 29
 - (ii) Acid gas emission of max. 20% as per IEC-754 (Part-I)
 - (iii) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM-D2843.

20.04.02 1.1KV Grade Copper Conductor Fire Survival Power Cables

- i) 1100 volt grade, 90 Deg. C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984. The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988. The cables can withstand 750 Deg. C temperature for three (3) hours.
- ii) Conductor
- a) Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.
 - b) A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.
- iii) Insulation
- a) Cores of the cable shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core -	Red, Black, Yellow or Blue
2 core -	Red & Black
3 core -	Red, Yellow & Blue
4 core -	Red, Yellow, Blue & Black
- iv) Laying up of cores (For multi core cables only)
- a) The core shall be suitably identified in accordance with IS: 9968 (Part-I).
 - b) The suitable fire retardant material fillers shall be used for filling in the interstices.

- c) Two layers of plain glass fiber binder tape shall be applied over the laid up cores.
- v) Inner Sheath
 - a) An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fiber tape over the insulation.
- vi) Armour
 - a) For Single core cables to be used in A.C system, the armouring over inner sheath shall consist of single layer of round copper wire.
 - b) For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.
- vii) Outer Sheath
 - a) The extruded outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.
 - b) Minimum value of 'Tensile Strength' and 'Percentage elongation at rupture' shall be 8 Newton/Sq. mm and 250% respectively.
 - c) The colour of outer sheath shall be black or any other colour agreed mutually between Owner and Supplier.

20.04.03 Flexible Trailing Cables

1100 V Grade flexible trailing cable shall be tinned copper of Class – 5 of IS – 8130, heat resistant electrometric compound based on EPR insulation, inner sheath of heat resistant electrometric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty electrometric compound FRLSH CSP outer sheath.

20.05.00 GENERAL REQUIREMENTS

20.05.01 Drum Length & tolerance

- i) Cable shall be supplied in wooden drums. The standard drum length of LT power cable may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 750 meter for multicore cable & single core 630 sqmm.



- ii) 1.1KV Copper Fire Survival Power cables shall be supplied in wooden drums. Each drum shall be minimum 750 metres single length of cable to ensure that there is no joint in the cable.
- iii) Allowable tolerance on individual drum length is ($\pm$) 5%.
- iv) The drums shall be designed based on weight, diameter, bending radius, and length of the cable. The surface of drum and outermost cable layer shall be covered with waterproof material. Both the ends of the cables shall be properly sealed to eliminate ingress of water during transportation, storage and erection.

20.05.02 Non-standard length

One drum length of each cable size can be of non-standard length (not less than 250 metres) subject to the condition that there shall not be any joint in the cable.

20.05.03 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

- a) HPGCL
- b) Manufacturer's name or trademark
- c) Voltage grade
- d) Year of manufacture
- e) Type of insulation and sheath, e.g. XLPE /PVC FRLSH, IE2/SE3 F.S. as applicable.
- f) No. of core and size of cables.
- g) Sequential length marking at an interval of 1m through out the length of the cable.
- h) ISI mark with C/ML Number
- i) Type of improved fire performance, e.g. FR /FR-LSH /FS.

20.05.04 Packing

- i) Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden drums shall be treated by immersing in copper nitrate solution
- ii) Cable shall be wound and packed on drums in such a manner that it shall be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose
- iii) A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions

shall be marked on the drum indicating the direction in which it should be rolled. Drum numbers are to be indicated on cable drums.

- iv) The cable drums should carry the following details in printed form (non-returnable): -
- HPGCL & Manufacturer's name or trade make
 - Type of cable & voltage grade
 - Year of manufacture
 - Type of insulation / sheath e.g. XLPE /PVC FRLSH, IE2/SE3 F.S. as applicable.
 - No. of core and size of cables
 - Cable code
 - Length of cable on drum
 - Direction of rotation, by arrow
 - Approx. gross mass.
 - ISI mark
 - IS / IEC number

20.06.00 TESTING PROCEDURE

20.06.01 Tests During Manufacture: -

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to Owner's representative during inspection / testing.

20.06.02 Type Tests: -

- Cables shall be type tested quality. For each type and rating of cables reports on all type tests as per relevant standards, and carried out with in last five years from the zero date shall be submitted.
- These reports shall be for the tests conducted on the similar type of cables proposed to be supplied under this contract. These tests should have been conducted from Govt. recognized Lab with in last 5 years from the zero date. If type test certificate are not available or in the case of type test report(s) are not found to be meeting the specification requirements, the same shall be conducted in the presence of the Owner free of cost.
- The following type tests shall be submitted: -

S. No.	Test	Reference Standard
1	Test on conductor	IS: 8130
2	Thickness of insulation & sheath	IS: 7098 (P-1)
3	Physical test on Insulation	IS: 7098 (P-1)
4	Physical Test on Outer Sheath	IS: 5831



S. No.	Test	Reference Standard
5	Ins. Resistance (Vol. Res.)	IS: 7098 (P-1)
6	HV Test at Room Temp	IS: 7098 (P-1)
7	Test on Armour Wire/ Strip	IS: 3975
8	Flammability Test	IS: 7098 (P-1)
9	Anti Termite & Rodent Test	As per standards
10	FRLSH Properties (For FRLSH PVC Only)	
i	Oxygen Index	ASTM D 2863
ii	Temperature Index	ASTM D 2863
iii	Smoke Density Rating	ASTM D 2843
iv	Acid Gas Generation	IEC-754-1
v	Flammability Test	IEC-332-1
vi	Swedish Chimney test	SS-424-1475 Class-F3

20.07.00 SPECIAL TESTS ON PVC 'FR-LS' MATERIAL

All the sizes of XLPE power cables of the 'FRLSH' PVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LS' type 'PVC' to meet these special tests: -

20.07.01 Oxygen Index Test

The Oxygen index shall not be less than 29 at room temperature. This test shall be carried out as per American National Std. ASTM-D-2863/ 77.

For determination of the temperature index, the oxygen index test shall be carried out at different temperature up to 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temperature index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

20.07.02 Acid gas emission test on sheath material: -

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.

20.07.03 Smoke density test on sheath material: -

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.



20.07.04 Flammability test on finished cable sample: -

This test shall be carried out as per the following method:

After the test, there should be no visible damages on the test specimen within 300mm from its upper end.

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly.

Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.

IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by Owner.

IEC Std: 332-1. – The cable should meet the requirement of all the above standards.

20.07.05 Temperature Index Test

The measured value of temperature index shall be not less than 250°C.

20.08.00 **ROUTINE TESTS**

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985:-

- a) High Voltage Test
- b) Conductor Resistance Test
- c) Partial discharge test (for screened cables) – on full drum length.

20.09.00 **ACCEPTANCE TEST**

The following test shall be carried out as Acceptance Test in the presence of HPGCL Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost:-

- a) High Voltage Test
- b) Conductor Resistance Test
- c) Tensile / wrapping test.
- d) Partial discharge test (In screened cables).
- e) Insulation Resistance/Volume resistivity test
- f) Measurement of thickness of insulation and sheath and other dimensions
- g) Tensile strength & elongation at break for insulation & sheath.
- h) Hot set test on XLPE insulation



- i) Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
- j) Acid gas generation test as per IEC-754-1.
- k) Smoke density test as per ASTM-D-2843/1977
- l) Oxygen index test as per ASTM-D 2863/1977
- m) Temp. index test as per ASTM-2863/77
- n) Test for Rodent and termite repulsion property

20.10.00 TEST WITNESS

Tests shall be performed in presence of Owner's representative. The Bidder shall give atleast fifteen (15) days advance notice of the date on which the tests are to be carried out.

20.11.00 TEST CERTIFICATES

- i) Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner's representative.
- ii) Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review.
- iii) The cables shall be dispatched from works only after receipt of Owner's written approval of the test reports.

20.12.00 DRAWINGS, DATA AND MANUALS TO BE FURNISHED FOR APPROVAL

Bidder shall submit the following minimum drawings and documents for approval during detail engineering stage.

- Design basis report
- Cable sizing calculation
- General arrangement drawings
- Technical data sheet
- Test reports
- Catalogues
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

DATA SHEET

LV POWER CABLES 1100V GRADE

1100 V grade, 90°C continuous rating under normal condition and 250°C short time rating under short circuit condition XLPE insulated FRLSH sheathed heavy duty, power cable conforming to following requirement and in line with IS 7098, IS 8130, IS 5831 and IS 3975.

S. NO.	DESCRIPTION	SPECIFICATION
1	Conductor	Stranded and compacted plain aluminium of grade H2 and class 2/stranded, high conductivity annealed plain copper, generally conforming to IS:8130
2	Insulation	Extruded Cross linked Polyethylene (XLPE).
3	Core Identification	By colour coding
4	Inner Sheath	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831 for multicore cable. Single core power cables need not be provided with any inner sheath.
5	Armour	Galvanised single round/ strip steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 grade for single core cables.
6	Overall Sheath	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831.
7	Oxygen Index	Minimum 29%
8	Drum	Conforming to IS-10418 (Wooden drum)

1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES

1100V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core / single layer of round galvanized steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 950 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

ANNEXURE – A**PREFERRED CABLE SIZES**

S. No.	Description of Cable
A	LV Power Cable
1.	2C x 2.5 sqmm Cu XLPE Cable
2.	2C x 16 sqmm Al XLPE Cable
3.	2C x 35 sqmm Al XLPE Cable
4.	3C x 2.5 sqmm Cu XLPE Cable
5.	3C x 16 sqmm Al XLPE Cable
6.	3C x 25 sqmm Al XLPE Cable
7.	3C x 35 sqmm Al XLPE Cable
8.	3C x 50 sqmm Al XLPE Cable
9.	3C x 70 sqmm Al XLPE Cable
10.	3C x 95 sqmm Al XLPE Cable
11.	3C x 150 sqmm Al XLPE Cable
12.	3C x 185 sqmm Al XLPE Cable
13.	3C x 240 sqmm Al XLPE Cable
14.	3C x 300 sqmm Al XLPE Cable
15.	3C x 400 sqmm Al XLPE Cable
16.	3.5C x 35 sqmm Al XLPE Cable
17.	3.5C x 70 sqmm Al XLPE Cable
18.	3.5C x 95 sqmm Al XLPE Cable
19.	3.5C x 185 sqmm Al XLPE Cable
20.	3.5C x 240 sqmm Al XLPE Cable
21.	3.5C x 300 sqmm Al XLPE Cable
22.	3.5C x 400 sqmm Al XLPE Cable
23.	4C x 4 sqmm Cu XLPE Cable
24.	4C x 16 sqmm Cu XLPE Cable
25.	1C x 630 sqmm Cu XLPE Cable
B	Cables for Electronic Earthing
1.	1C x 35 sqmm Cu XLPE Cable
2.	1C x 150 sqmm Cu XLPE Cable
C	FS Power Cables
1.	4C x 4 sqmm Cu FS Cable
2.	2C x 25 sqmm Cu FS Cable
3.	2C x 50 sqmm Cu FS Cable

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN				SPEC. NO :			DATE:	
			CUSTOMER :				QP NO.: PE-QP-999-507-E002, REV 03				
			PROJECT:				PO NO.:				
			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 1 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

1.0 RAW MATERIALS														
1.1 Aluminium /Copper Rods														
	(Conductor/ Armour Wire)	a) Make	MA	Verify	100%	100%	Manufacture r approved source	Manufacture r approved source	Test Cert.	✓	V	V	-	
		b) Grade	MA	-do-	-do-	-do-	IS:8130 (Al), IS:613 (Cu)	IS:8130 (Al), IS:613 (Cu)	-do-	✓	V	V	-	
		c) Resistivity	MA	Electrical Tests	Manufac turer std.	Manufa cturer std.	IS:613 (Cu), IS:5082 (Al)	IS:613 (Cu), IS:5082 (Al)	-do-	✓	P	V	-	
1.2 XLPE Compound for insulation														
		a) Make	MA	Verify	100%	100%	Manufacture r approved source	Manufacture r approved source	Test Cert.	✓	V	V	-	
		b) Type/ Grade	MA	-do-	-do-	-do-	-do-	-do-	-do-	✓	V	V	-	
		c) Shelf life/ Storage condition	MA	-do-	-do-	-do-	Compound mfg std	Compound mfg std	-do-	✓	V	V	-	

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	VIKAS KUMAR SINGH	Digitally signed by VIKAS KUMAR SINGH DN: cn=VIKAS KUMAR SINGH, o=BHEL, ou=PE PERI, email=VIKASK@bhel.co.in, c=IN, 2.5.4.2.1=82309-10297	Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS		STANDARD QUALITY PLAN				SPEC. NO :			DATE:	
			CUSTOMER :				QP NO.: PE-QP-999-507-E002, REV 03				
			PROJECT:				PO NO.:				
			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE		SECTION: II			SHEET 2 OF 11	

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

1.3	PVC Compound (for sheath)													
		a) Make	MA	Verify	100%	100%	Manufacture r approved source	Manufacture r approved source	Test Cert.	✓	V	V	-	
		b) Type/ Grade	MA	-do-	-do-	-do-	Approved datasheet	Approved datasheet	-do-	✓	V	V	-	
		c) Shelf life/ Storage condition	MA	-do-	-do-	-do-	Compound Manufacture r std.	Compound Manufacture r std.	-do-	✓	V	V	-	
1.4	Fillers (as applicable)	1. Make/ Type/ Grade	MA	Verify	Manufac turer standard	Manufa cturer standar d	Manufacture r approved source & Approved datasheet	Manufacture r approved source & Approved datasheet	Test Cert.	✓	P	V	-	Fillers material chosen shall be compatible with the temperatur e rating of the cable and shall have no deleterious

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Reviewed by:			Reviewed by:					Approved by:			

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			CUSTOMER :				QP NO.: PE-QP-999-507-E002, REV 03				
			PROJECT:				PO NO.:				
			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 3 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

														effect on any other component of cable)
1.5	Galvanised steel wire/strip for Armour (as applicable)	GENERAL:												
		1. Make	MA	Verify	Manufac turer std.	Manufa cturer std.	Manufacture r approved source	Manufacture r approved source	Test Cert.	✓	P	V	-	
		2. Dimension	MA	Measurem ent	1 sample each size	1 sample each size	Appd. Data Sheet	Appd. Data Sheet	-do-		P/ V	-	-	
		3. Phy.and Elec. Properties	MA	Physical & Electrical Tests	Sample*	Sample *	IS 3975	IS 3975	-do-	✓	P/ V	V	-	
		4.Galvanization Quality (Acceptance test as per IS 3975)	MA	Galv.Tests	-do-	-do-	IS 3975	IS 3975	-do-		P/ V	-	-	

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 4 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

1.6	Wooden Drum (if applicable as per approved data sheet)	1. Phy. & Constructional checks	MA		Manufac turer Plant Std.	Manufa cturer Plant Std.	IS 10418	IS 10418	Test Cert.	✓	P	V	-	
		2. Anti termite treatment	MA	Chem.	Manufac turer Plant Std.	Manufa cturer Plant Std.	Manufacture r Plant Std.	Manufacture r Plant Std.	-do-	✓	P	V	-	
1.7	Steel Drum (if applicable as per approved data sheet)	1. Dimension	MA	Meas.	-do-	-do-	Approved drg	Approved drg	Test Cert.	✓	P	V	-	
		2. Surface finish	MA	Visual	-do-	-do-	-	Surface shall be smooth	-do-	✓	P	V	-	
2.0	IN PROCESS													
2.1	Wire Drawing	1. Size	MA	Dimension al	Plant Mfg. Std.	Plant Mfg. Std.	Approved datasheet	Approved datasheet	Inspe ction Repo rt/	✓	P	V	-	

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Reviewed by:			Reviewed by:					Approved by:			

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 5 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

										Test report					
		2. Surface finish	MA	Visual	-do-	-do-	Surface shall be smooth	Surface shall be smooth	-do-	✓	P	V	-		
		3. % of Elongation	MA	Mechanical	-do-	-do-	IS 8130	IS 8130	-do-	✓	P	V	-		
2.2	Stranding of wires	1. No. of wires	MA	Counting	One Sample of each size	One Sample of each size	Approved data sheet	Approved data sheet	Inspe ction Repo rt/ Test report	✓	P	V	-		
		2. Resistance	CR	Electrical	-do-	-	-do-	-do-	-do-	- do-	P	-	-		
		3. Sequence, lay length & Direction	MA	Visual, Meas.	One Sample of each size	-	Manufacture r Std. / Approved data sheet	Manufacture r Std. / Approved data sheet	-do-		P	-	-		
		4. Surface Finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	-do-		P	-	-		

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE		SECTION: II			SHEET 6 OF 11	

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

		5. Dimension	MA	Measurem ent	One Sample of each size	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
2.3	Core Insulation (XLPE) (No repair permitted)													
		1. Surface finish	MA	Visual	100%	100%	Free from bulging, burnt particles, lumps, cuts & scratches	Free from bulging, burnt particles, lumps, cuts & scratches	Inspe ction Repo rt/ Test report	✓	P	V	-	
		2. Eccentricity & Ovality #	CR	Measurem ent	One Sample of each size	One Sample of each size	Manufacture r Std / Approved data sheet	Manufacture r Std / Approved data sheet	-do-	✓	P	V	-	
		3. Insulation Thickness	CR	Measurem ent	-do-	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		4. Dia over insulation	MA	Measurem ent	-do-	-	-do-	-do-	-do-		P	-	-	

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Reviewed by:			Reviewed by:		

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE		SECTION: II			SHEET 7 OF 11	

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

		5. Tensile Strength & % Elongation	MA	Mechanical	100%	-	IS:1554-I, IS:5831	IS:1554-I, IS:5831	-do-		P	-	-	
		6. Spark Test or Water immersion test	CR	Electrical	100%	-	Manufacture r Std	Manufacture r Std	-do-	Ma nuf act urer Std	P	-	-	
2.4	Core Laying	1. Dia over laid up core	MA	Measurem ent	One Sample of each size	-	Approved data sheet	Approved data sheet	Inspe ction Repo rt/ Test report		P	-	-	
		2. Sequence of lay & direction	MA	Visual & Meas.	-do-	-	IS 7098-I & Mfr. Std.	IS 7098-I & Mfr. Std.	-do-		P	-	-	
						-								
2.5	Inner Sheath Extrusion (as applicable)	1. Surface finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	Inspe ction Repo rt/ Test report		P	-	-	
		2. Thickness	CR	Measurem ent	One Sample	-	Approved data sheet	Approved data sheet	-do-		P	-	-	

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 8 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

					of each size									
		3. Dia over inner sheath	MA	-do-	-do-	-	-do-	-do-	-do-		P	-	-	
		4. Colour	MA	Visual	-do-	-	-do-	-do-	-do-		P	-	-	
2.6	Armour (as applicable)	1. No. of wires/Strips	MA	Counting	At the start of the process	-	Manufacture r Std	Manufacture r Std	Inspe ction Repo rt/ Test report		P	-	-	
		2. Lay length / Direction	MA	Visual & Meas.	-do-	-	Manufacture r Std.	Manufacture r Std.	-do-		P	-	-	
		3. Dia over armouring	MA	Measurem ent	-do-	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		4. Coverage	MA	Measurem ent	-do-	-	-do-	-do-	-do-		P	-	-	
2.7	Outer Sheath Extrusion (No repair permitted)	1. Surface finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	Inspe ction Repo rt/		P	-	-	

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			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE	SECTION: II			SHEET 9 OF 11		

SI. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

									Test report					
		2. Sheath Thickness	CR	Measurem ent	One Sample of each size	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		3. Dia over outer sheath	MA	-do-	-do-	-	-do-	-do-	-do-		P	-	-	
		4. Embossing/ Sequential Marking	MA	Visual	100%	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
3.0	Final Inspection (INTERNAL)	1. Routine Test	CR	Electrical Tests & Measurem ent	100%	100%	#	#	-do-	✓	P	V	V	#. Refer Annexure-A to QP
4.0	Final Inspection (EXTERNAL)	1. Finish & Length (Cable & cable drum)	MA	Visual	One drum	One drum	Approved data sheet	Free from Porosity, Bulging, Burnt particles, lumps, cuts & scratches	Inspe ction Repo rt/ Test report	✓	P	W	W	

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		PROJECT:		PO NO.:		
		ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 10 OF 11	

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLAS S	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANC E NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	

		2. Dimension	MA	-do-	IS 7098-I	IS 7098-I	Approved data sheet	Approved data sheet	-do-	✓	P	W	W	
		3. Armouring - Coverage & No.of Wires/Strips	MA	Visual & Meas.	-do-	-do-	-do-	-do-	-do-	✓	P	W	W	
		4. Marking & Colour Coding	MA	Visual	-do-	-do-	-do-	-do-	-do-	✓	P	W	W	
		5. Acceptance Tests	CR	Phy, Elect. Tests & FRLS Tests	Sample #	Sample #	#	-do-	-do-	✓	P	W	W	#: Refer Annexure-A / Annexure-B to QP.
		6. Type Tests	CR	Physical & Electrical Tests	Sample #	Sample #	-do-	-do-	-do-	✓	P	W / V	W / V	'Witness' required for conduction of Type test; else 'Verification' of type test(s) reports to be done.

BHEL					
ENGINEERING			QUALITY		
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			PROJECT:				PO NO.:				
			ITEM: LT XLPE POWER CABLE		SYSTEM: CABLE		SECTION: II			SHEET 11 OF 11	

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1	2	3	4	5	6		7	8	9	* D	**			
					M	B/C					M	B	C	

														#: Refer Annexure-A & Annexure-B to QP.
5.0	Packing	End sealing / Polythene wrapping	MA	Visual	100%	100%	Approved data sheet	Approved data sheet	-do-	✓	P	V	-	

NOTES:

A). For lists of routine tests, acceptance tests & type tests refer Annexure-A to SQP.

B). For project specific additional tests (if any); refer Annexure-B to SQP.

C). Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch no. should be traceable to the final cable drum number or batch no.

D). Cable manufacturer to maintain all quality records identified as per all QP stages enumerated above whether it is identified for BHEL verification or witness or not.

E). Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER

P: PERFORM, **W**: WITNESS, **V**: VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR**: CRITICAL

D: DOCUMENTATION

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
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	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	VIKAS KUMAR SINGH	Digitally signed by VIKAS KUMAR SINGH DN: cn=VIKAS KUMAR SINGH, o=BHEL, ou=QA/QA MEDIA, email=VIKASKSINGH@BHEL.IN, c=IN Date: 2024.02.27 19:09:09 +05'30'	Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

	ANNEXURE-A TO QP	CUSTOMER:	PROJECT TITLE	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER: PE-QP-999-507-E002, R03	SPECIFICATION TITLE:
	SHEET 1 OF 4	SYSTEM: CABLE	ITEM: LT XLPE POWER CABLE	DOC. NO.

TYPE/ ACCEPTANCE/ ROUTINE TEST REQUIREMENTS

A. Type Test Conduction:

- Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.
- Sampling:
 - Type test to be conducted on one size for each type (Al/Cu conductor) of cable.
 - FRLS & Flammability Test to be conducted only on one sample.
- Repeat type test(s) are not required, in case the requirements of note no. 2, clause no. 2.2 of IS 7098 1 (as per amendment no. 5 of 2012) are met.

B. Acceptance Test Conduction:

- Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance tests.
- Sampling:
Sampling for acceptance tests shall be as per Appendix-B (Clause 15.2.2) of IS: 7098 Part-I.
- Flammability Test to be conducted only on one sample.

C. Routine Test Conduction:

- Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

D. Tests listed in S. No-7.0 & 8.0 shall be conducted only on one sample.

<u>S. No.</u>	<u>TEST</u>	<u>APPLICABLE FOR</u>	<u>TEST CONDUCTION REQUIRED AS</u>	<u>REFERENCE STANDARD</u>	<u>REMARK S</u>
1.0	Tests for Conductor				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	Internal in process Test Report to be furnished for acceptance test

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	ANNEXURE-A TO QP	CUSTOMER:	PROJECT TITLE	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER: PE-QP-999-507-E002, R03	SPECIFICATION TITLE:
	SHEET 2 OF 4	SYSTEM: CABLE	ITEM: LT XLPE POWER CABLE	DOC. NO.

<u>S. No.</u>	<u>TEST</u>	<u>APPLICABLE FOR</u>	<u>TEST CONDUCTION REQUIRED AS</u>	<u>REFERENCE STANDARD</u>	<u>REMARK S</u>
II.	Tensile test	For aluminium conductor only (Not applicable for compacted circular or shaped conductor)	T, A	IS 10810 Pt 2	
III.	Wrapping test	For aluminium conductor only (Not applicable for compacted circular or shaped conductor)	T, A	IS 10810 Pt 3	
IV.	Resistance test	For Al/Cu	T, A, R	IS 10810 Pt 5	
2.0	<u>Tests for Armour Wires/Strips</u>				
I.	Measurement of dimensions	Applicable for Aluminium wire & GS wire/Strip	T	IS 10810 Pt 36	
II.	Tensile test	Applicable for Aluminium wire & GS wire/Strip	T	IS 10810 Pt 37	
III.	Elongation at break test	Applicable for GS wire/Strip only	T	IS 10810 Pt 37	
IV.	Torsion test	For GS round wire only	T	IS 10810 Pt 38	
V.	Winding / Adhesion Test	For GS strip only	T	IS 10810 Pt 39	
VI.	Uniformity of Zinc coating test	For G. S. wires/Strip only	T	IS 10810 Pt 40	
VII.	Mass of Zinc coating test	For G. S. wires/Strip only	T	IS 10810 Pt 41	
VIII.	Resistivity test	Applicable for Aluminium wire & GS wire	T	IS 10810 Pt 42	
IX.	Wrapping Test	Applicable for Aluminium wire	A	IS 10810 Pt 3	
3.0	<u>Physical Tests for XLPE Insulation & PVC sheath</u>				
I.	Test for thickness	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T, A	IS 10810 Pt 6	
II.	Tensile strength and elongation test at break	Applicable for XLPE insulation & PVC outer sheath			
(a)	Before ageing		T, A	IS 10810 Pt 7	
(b)	After ageing		T, A	IS 10810 Pt 7	

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	ANNEXURE-A TO QP	CUSTOMER:	PROJECT TITLE	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER: PE-QP-999-507-E002, R03	SPECIFICATION TITLE:
	SHEET 3 OF 4	SYSTEM: CABLE	ITEM: LT XLPE POWER CABLE	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARK S
III.	Ageing in air oven	Applicable for XLPE insulation & PVC outer sheath	T	IS 10810 Pt 11	
IV.	Hot set test	For XLPE insulation only	T, A	IS 10810 Pt 30	
V.	Loss of mass in air oven test	For PVC outer sheath only	T	IS 10810 Pt 10	
VI.	Shrinkage test	For XLPE insulation & PVC outer sheath only	T	IS 10810 Pt 12	
VII.	Hot deformation test	For PVC outer sheath only	T	IS 10810 Pt 15	
VIII.	Heat shock test	For PVC outer sheath only	T	IS 10810 Pt 14	
IX.	Thermal stability test	For PVC outer sheath only	T	IS 10810 Pt 60	
X.	Water absorption (gravimetric) test	For XLPE insulation only	T	IS 10810 Pt 33	
4.0	Improved Fire performance (FR-LSH) Tests				
I.	Oxygen index test	<i>For inner (as applicable)/ outer sheath</i>	T, A	IS 10810 Pt 58 / ASTM D 2863/ NES 715-I	Applicable for Inner Sheath also, if the same is indicated in Approved Datasheet
II.	Smoke density test	<i>For inner (as applicable)/ outer sheath</i>	T	IS 10810 Pt 63 / ASTM D 2843	
III.	Acid gas generation test	<i>For inner (as applicable)/ outer sheath</i>	T, A	IS 10810 Pt 59 / IEC-754-1	
IV.	Temperature Index Test	<i>For inner (as applicable)/ outer sheath</i>	T	IS 10810 Pt 64 / ASTM D 2863	
5.0	Flammability Tests				
I.	Flammability test for bunched cables	For complete cable	T	IS 10810 Pt 62/ IEC-60332 (Part-3-23-Cat-B)	Test & Category applicable as indicated in Approved Datasheet
II.	Flammability test for single cable	For complete cable	T, A	IS: 10810 Pt 61 / IEC:60332 Part-1	
III.	Swedish chimney test	For complete cable	A	SEN SS 424 1475 (Class F3)	
IV.	Flammability test	For complete cable	A	IEEE: 60383	
6.0	Electrical Tests				
I.	High Voltage Test	For complete cable	T, A, R	IS 10810 Pt 45	

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	ANNEXURE-A TO QP	CUSTOMER:	PROJECT TITLE	SPECIFICATION NUMBER:
		BIDDER/VENDOR:	QUALITY PLAN NUMBER: PE-QP-999-507-E002, R03	SPECIFICATION TITLE:
	SHEET 4 OF 4	SYSTEM: CABLE	ITEM: LT XLPE POWER CABLE	DOC. NO.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
II.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T, A	IS 10810 Pt 43	
7.0	Anti-rodent and Termite Repulsion test	For PVC outer sheath only	A	Refer Note	Test applicable if indicated in Approved Datasheet
8.0	Anti-Fungal Test	For PVC outer sheath only	A	Self-certification by vendor for anti-fungal property.	
9.0	Special Tests/ Optional test				
I.	Hydrolytic Stability Test	For complete cable	**	ASTM D 3137:81	Test applicable if indicated in Approved Datasheet
II.	Ultraviolet Radiation Test	For complete cable	**	BS EN ISO 4892-2	
III.	Cold bend test	For PVC outer sheath only	O (Optional)	IS 10810 Pt 20	
IV.	Cold impact test	For PVC outer sheath only	O (Optional)	IS 10810 Pt 21	
V.	Resistance test for armour	Applicable for Aluminium wire & GS wire	O (Optional)	Table 7, IS 7098 Pt 1	

**** These tests shall be conducted on one sample for the entire contract and duration of these tests shall be 14 days.**

Note: A few chippings of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60-degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a thick filter paper and allow soaking. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound.

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Annexure “B” to Standard Quality Plan

PROJECT SPECIFIC REQUIREMENT

PROJECT:

PACKAGE: LT XLPE POWER CABLE

<u>S. No.</u>	<u>TEST</u>	<u>APPLICABLE</u>	<u>TEST CONDUCTION REQUIRED AS</u>	<u>REFERENCE STANDARD</u>	<u>REMARKS</u>
1.					
2.					

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY
NAME: DESIGNATION:	NAME: DESIGNATION:	NAME: DESIGNATION:	NAME: DESIGNATION: